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THE FLUID POWER INSTITUTES TESTED PROCEDURES FOR INTRODUCING EMERGING TECHNOLOGIES, 1966.

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TO EXPLORE NEW WAYS OF INTRODUCING EMERGING TECHNOLOGIES INTO SCHOOLS, FLUID POWER INSTITUTES WERE HELD IN 1964 AND 1965, AND THE SUCCESSFUL PROCEDURES FROM THE TWO WERE THE BASIS FOR PLANNING THE 1966 INSTITUTES HELD IN FIVE INSTITUTIONS HAVING TEACHER EDUCATION PROGRAMS. SEVENTY-FIVE HIGH SCHOOL OR COLLEGE LEVEL TEACHERS FROM 25 STATES PARTICIPATED IN PROFESSIONAL SEMINARS, SOCIAL-PROFESSIONAL ACTIVITIES, AND AN INSTRUCTIONAL PROGRAM COVERING 11 MAIN TOPICS IN HYDRAULICS, EIGHT IN PNEUMATICS, RELATED LABORATORY EXPERIENCES, AND PLANNED FIELD TRIPS FOR A MINIMUM OF 166 CLOCK HOURS. AVERAGE SCORES ROSE FROM 26.4 ON PRETESTS TO 43.4 ON POSTTESTS, OVER 1,000 LABORATORY ASSIGNMENTS WERE COMPLETED, INDUSTRY CONTRIBUTED THE SERVICES OF 115 SPECIALISTS FOR 453 HOURS AT NO COST, AND MID-YEAR FOLLOWUP REPORTS SHOWED THAT PARTICIPANTS HAD COMPLETED 174 OF 294 PLANNED ACTIVITIES AND OTHERS WERE BEING PLANNED. SOME OF THE RECOMMENDED PROCEDURES FOR INTRODUCING A NEW TECHNOLOGY INTO SCHOOLS BY MEANS OF MULTI-INSTITUTE PROGRAM ARE--(1) SELECT STAFF MEMBERS AS SOON AS POSSIBLE AND ASSIGN RESPONSIBILITIES, (2) INVITE INSTITUTIONS KNOWN TO HAVE AN INTEREST AND THOSE WHICH MAY POSSIBLY BE INTERESTED TO APPLY FOR AN INSTITUTE, (3) INVITE THE COOPERATION OF INDUSTRY, (4) PLAN THE ENTIRE PROGRAM AS A UNIT SO THAT COOPERATION OF INDUSTRY, COORDINATION, EVALUATION, FINAL REPORT, AND FOLLOWUP WILL BE COORDINATED, (5) INCLUDE INSTRUCTION AND LABORATORY EXPERIENCES, PROFESSIONAL SEMINARS, AND SOCIAL-PROFESSIONAL EXPERIENCES IN THE PLANNING, AND (6) SELECT PARTICIPANTS BY ESTABLISHED CRITERIA ON APPLICATION FORMS. IT WAS FOUND THAT THE TECHNICAL SOCIETY REPRESENTING THE TECHNOLOGY CAN BE EFFECTIVE IN PLANNING, CONDUCTING, AND EVALUATING THE MULTIPLE-INSTITUTE PROGRAM AND THAT SUCH AN AGENCY UNIQUELY FACILITATES THE COORDINATED COOPERATION OF THE INDUSTRY. FORMS AND INSTRUCTIONAL MATERIALS USED IN THE 1966 INSTITUTES ARE INCLUDED. (HC)

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The Fluid Power Institutes Tested Procedures For Introducing Emerging Technologies

1966 INSTITUTE

Vocational and Technical Education
Grant Number 062278-0728

Vocational Education Act of 1963, Section 4(C)

GERALD BAYSINGER

FLUID POWER SOCIETY
THIENSVILLE, WISCONSIN

1967

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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THE FLUID POWER INSTITUTES

TESTED PROCEDURES FOR INTRODUCING EMERGING TECHNOLOGIES

1966 INSTITUTES

Vocational and Technical Education
Grant Number ~~062278-0728~~
3-6-062278-0728
Vocational Education Act of 1963, Section 4(C)

Gerald Baysinger
Fluid Power Society
Thiensville, Wisconsin

1967

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SUMMARY

TITLE:
THE FLUID POWER INSTITUTES
TESTED PROCEDURES
FOR
INTRODUCING EMERGING TECHNOLOGIES

DURATION: 15 April 1966 -- 30 June 1967

GRANT NUMBER:
Vocational and Technical Education
Grant Number 062278-0728
Vocational Education Act of 1963, Section 4(C)

INVESTIGATOR:
Theodore Pearce
Executive Vice President

AGENCY:
The Fluid Power Society
Thiensville, Wisconsin 53092

I

PROGRAM OBJECTIVES

ONE: PREPARE TEACHERS AND INSTRUCTORS. In short supply in the Nation's schools are instructional programs in Fluid Power, one of the emerging technologies which has many industrial applications: processing materials; manufacturing and assembly; mobile equipment for agriculture, lumbering, mining, construction, road building and others; aero-space; and marine. In these industries, operatives, maintenance and service employees, skilled craftsmen who install and assemble components and circuitry, and technicians who trouble-shoot and make corrections to maintain efficient operation and to reduce down-time, need basic theory and a working knowledge of hydraulics, pneumatics, and fluidics. But, as revealed in an informal survey conducted earlier by the National Fluid Power Association, there are too few, and in some areas, no instructional programs available to assist in preparing young people for these new and changing occupations.

One purpose of the Fluid Power Institutes, therefore, was to prepare additional and needed teachers and instructors, selected from those now teaching, who could introduce instructional programs in their own schools.

TWO: TEST SELECTED PROCEDURES FOR INTRODUCING OTHER EMERGING TECHNOLOGIES. The 1965 Fluid Power Institutes were conceived and planned as a pilot program and, hence, experimental. Many of the practices used, however, were first tried in the 1964 Fluid Power Institute, limited to teacher educators, which was financed by the National Fluid Power Association. As a pilot program, the 1965 Institutes employed these supplemented by a wide variety of other practices from which the most promising were selected for use in the 1966 Institutes.

The second program objective, therefore, was to test these procedures as a group, further refine them, and recommend their use in introducing other emerging technologies.

The selected procedures are comprehensive and include planning, preparation, conducting, coordinating and supervising, and evaluating and reporting.

II

PROCEDURES

ONE:PLANNING. The administrative and coordinating agency for the 1966 Institutes was the Fluid Power Society, an incorporated non-profit technical and educational organization consisting of 48 chapters; it co-sponsors national conferences and seminars, cooperates with other technical societies, and holds memberships in the American Standards Association and the Joint Industry Council. Executive Vice President is Mr. Theodore Pearce who has had previous experience as Director of Field Services for a state university, and who served as Chief Investigator.

Using prepared guide lines provided for writing proposals, Mr. Pearce first prepared and submitted a proposal to the Office of Education which was given tentative approval. To describe the program more fully, and to compile a new budget within the funds available, application blanks were then mailed to institutions known to the Fluid Power Society as having educational programs at the teacher education level or which have a strong interest in establishing such programs. From these, five institutions were selected and a revised proposal and budget were submitted which were subsequently approved. Because of budget limitations, participants were reimbursed for food and dormitory expense plus minimum travel costs; no funds were available for standard participant support and dependency allowances.

Using a nine-point criteria, five institutions were selected:

1. Bradley University -- Illinois
2. California State College -- Los Angeles
3. Hampton Institute -- Virginia
4. Trenton State College -- New Jersey
5. Wayne State University -- Michigan

Staff members needed for program planning, coordination and supervision, and evaluation were then appointed. For planning and evaluation, Gerald Baysinger was selected; for coordination and supervision, Fred Lamb; for the Evaluation Committee:

Chairman: Dr. Robert Worthington
Assistant Commissioner for
Vocational Education
Trenton, New Jersey

Professor Joseph P. Arnold
Purdue University

George F. Carlson
Minnesota Rubber Co.

Warren Koerner
Director of Technical Education
Chicago Public Schools

John J. Pippenger
Racine Hydraulics Development Corporation

Dr. Victor Spathelf, President
Ferris State College

Edwin Taibl
Milwaukee Institute of Technology

Carl Turnquist
Director of Vocational Education
Detroit Public Schools

Consultant: Howard Hogan
Arlington, Virginia

Next, a comprehensive plan was prepared by the Staff for use in program planning, coordinating-supervising the various institutes, and evaluation of outcomes. Copies were provided staff members, Evaluation Committee members, institute directors and instructors.

Meanwhile, a small advertisement was written and placed in School Shop Magazine, and an announcement and application were prepared and duplicated. These were mailed to those answering the advertisement, distributed at professional meetings in the various States, and institute directors mailed copies to schools and school systems within their service areas. Applications were returned to the institutions.

On April 15 and 16, staff and institute directors met in Milwaukee. Comprehensive plans were reviewed, responsibilities of the director were studied in detail, importance of accuracy in reports and due dates for reports were stressed, dates were established for visits by the Coordinator and for submitting working copies of instructional programs. Because of a death in the family, one institute director could not attend, but the Coordinator later visited him and worked with him individually.

TWO: PREPARATION FOR FLUID POWER PROGRAMS. Previous to starting dates, the Coordinator visited each institution and, using a checklist prepared for that purpose, inspected and rated facilities: living accomodations, food service, lecture-demonstrations, laboratory, and group study. For all institutions, the average rating was between

Good and Excellent; no facility at any institution was found to rate less than Adequate. The purpose of the inspection, however, was not to rate facilities as such but to identify any problems and to explore alternates so as to maximize physical facilities.

Meanwhile, each director planned the program for his own institute using guide lines in the comprehensive plans, submitted a checking copy to the Coordinator and, following approval with or without suggested changes, duplicated revised copies for later distribution to participants. As a result, all programs provided three distinct groups of activities: instructional program, professional seminar, and social-professional activities. All instructional programs covered eleven main topics in hydraulics, eight in pneumatics, related laboratory experiences, and planned field trips; time allocated was 166 clock hours but this was exceeded at four institutions. Seminars provided for both individual and group activity in completing four assignments: prepare a course outline, compile a list of texts and references, compile a list of instructional aids including laboratory equipment and supplies, plan a revised or new laboratory; time allocated for lecture and discussion was 24 clock hours which was supplemented by many hours of individual and group study during the evenings and on week ends. Social-professional activities were voluntary rather than required and included campus activities, trips to nearby points of interest, cultural activities, and others; for these, time allocation was not specified but ranged from 7.5 to 32 hours.

As reported earlier, applications were sent to the institutions preferred by candidates. Upon receiving these, directors checked eligibility of each applicant and notified each by letter of the decision made. The Coordinator, visiting each institution before the starting date, examined applications, reviewed decisions, and verified by letter to the Fluid Power Society that participants accepted met criteria for eligibility. These totalled 75 and represented 25 different States; of these, seven States had not been previously represented in the 1965 Institutes. High School teachers numbered 35 or almost one-half of the total; vocational schools -- 9; community and junior colleges -- 3; technical institutes -- 7; four-year technology schools -- 7; and teacher education -- 7. Guest participants from other countries numbered 7.

As a part of the preparation for the 1966 Institutes and previous to firm committments to the institutions selected, qualifications of the seven instructors were examined and evaluated by members of the Evaluation Committee representing industry supplemented by members of the Education Committee of the Fluid Power Society. Individual judgements were made on each of five classifications for each instructor; those were then combined into one evaluation. As a result of these combined judgements, four instructors were considered to be excellent; three were good; none were rated below good. Of the seven instructors, five had participated in previous institutes; four of the five directors had participated in the 1964 Institute.

THREE: SUPERVISION AND COORDINATION. Previous to the beginning of the summer institutes, the Coordinator had conducted the planning conference with the directors, revised or made various suggestions for improving programs, visited each institution and inspected facilities using a check list, and checked and validated participant selection.

When the programs were under way, the Coordinator again visited each institution where he observed selected class meetings, talked with participants, and served as consultant to the director. At the end of the program, he collected from the directors the various reports and evaluation data.

FOUR: EVALUATION. Comprehensive plans described earlier included procedures and instruments for collecting data relative to quality of the institute programs and, cooperation of industry; a follow-up study was also included.

To assess quality of programs, initial and final examinations which sampled each major topic were constructed, pre-tested, and administered; appraisals by participants of quality of each lecture-demonstration by both instructors and guest-lecturers, of the educational value and nature of laboratory experiences, and of the social-professional activities were obtained from daily log sheets constructed for those purposes and provided each participant; in addition, daily log sheets were kept showing numbers of seminar assignments made and those completed.

To assess the cooperation of industry, directors kept records and reported on the number of Fluid Power Society members and hours they spent in consultation, assisting with field trips, and as guest-lecturers. In addition, directors kept records and reported type and number of various instructional materials and teaching aids contributed by industrial organizations. Finally, activities of the Fluid Power Society were recorded.

Probably the most valid measure of quality of the program is the data obtained from a follow-up study. This was done by having each participant select activities from a prepared check list which he believed he could accomplish during the following year, and obtaining from him by mail a progress report at mid-year and a final report at the end of the school year.

III

RESULTS AND CONCLUSIONS

RESULTS. The comprehensive plan which included planning, preparation, conducting, coordinating and supervising, and evaluation and reporting with copies provided all staff directors and instructors gave the program positive direction, reduced or eliminated time-consuming communications concerning responsibility and procedures, and resulted in efficient and carefully planned programs.

Before the starting date of each institute, preparation was complete: physical facilities were inspected and found to be good; institute program was planned, reviewed, and duplicated; instructors were judged to be competent to carry out the program; and eligibility of each participant was verified.

When each institute was operating, the Coordinator provided any assistance required, and verified the expected quality of programming and instruction through personal visits.

From Evaluation of collected data, it was concluded that the program was of high quality. First, average scores on the initial test of fifty items ranged from 17.5 to 28.8 with 26.4 as an average for all institutes. Average scores on the final test of fifty items ranged from 34.35 to 44.3 with 43.4 an average for all institutes. At the same time, the spread of the scores (standard deviation) was reduced from 8.7 to 4.5. Second, instructors and guest lecturers were judged by participants as being thorough. Third, the 75 participants completed 1,011 selected laboratory assignments which they appraised as having high educational value. Fourth, required seminar assignments were completed by all but one participant. Fifth, the number of social-professional activities provided totalled 31 for all institutes in which participation was 83.2 per cent. Sixth, the services of 115 specialists who spent a total of 453 hours was provided by industry at no cost. Industry also contributed a total of 11,258 catalogs, books, manuals, technical reports, bulletins, and instructional devices. The Fluid Power Society, in addition to other services, gave each participant a guest membership which included subscription to trade magazines: "Hydraulics and Pneumatics", and "Fluid Power International" published in London England. Finally, a follow-up study consisting of initial plans, progress reports at mid-year, and final reports revealed that of 294 planned activities, 174 or 46.4 per cent had been completed; 104 or 27.7 per cent were in the planning stage; 69 or 18.4% were scheduled for next year. Thus, the accomplishments of the 1966 participants were approximately the same as those of 1965 which was not expected because budget limitations excluded the standard institute allowances.

CONCLUSIONS. The procedures which proved to be successful in the first Fluid Power Institute in 1964 were selected and used again in the 1965 Institutes supplemented by others previously untried. From all of these, the most promising were selected for testing in the 1966 Institutes. In the preceding chapters, these various activities and approaches have been described, and the effectiveness of each, as contributing to the total success of the institutes, has been appraised. As a group, these selected procedures for introducing a new technology into schools by means of a multi-institute program constitute the conclusions and recommendations of this pilot study.

1. Select staff members as soon as possible, and assign responsibilities. A minimum of three are needed; one for administration, and two for planning and coordination. Dividing these different responsibilities is advantageous because of the amount of detail in each.

2. Invite institutions known as having an interest, and those which may possibly be interested, to apply for an institute using a form prepared for that purpose. Needed information includes previous institute experience of the director; technical and professional qualifications of the instructors; laboratory, lecture-demonstration, and group study facilities; living accomodations; potential field trips and other pertinent industrial resources; and, of course, budget.

   Next, make a tentative selection of institutions using the information above as criteria; include geographical area to be served. For minimum coverage, experience has shown that a minimum of ten institutes are needed.

   Before final selection is made, arrange for the coordinator to visit each institution to inspect facilities using a check list, and to meet with the tentative director and instructors.

3. Invite the cooperation of industry by mail or at scheduled meetings. Describe the program and its objectives, and indicate the nature of assistance or service needed such as: local advisory committees, guest-lecturers, field trips, possible customer training programs, instructional material and teaching aids.

   Through the appropriate technical societies, arrange guest memberships for participants and their identification with local or nearby chapters.

4. Plan the entire program as a unit so that institute programs, cooperation of industry, coordination, evaluation, final report and a follow-up study will be coordinated, and so that each person will know his own responsibilities and how these are inter-related to those of others.
5. In planning for institute programs, include instruction and laboratory experiences, professional seminar, and social-professional experiences. For planning, outline informational content and specify seminar topics and assignments; establish guide lines and minimum time allocations for each phase of the program. Recommend the use of an advisory committee. Include provisions for early staff review and approval of each institute program.
6. For participant selection, establish criteria, design and duplicate application forms, and select publicity media. If the institute program is basic and introductory, participants may be selected from various educational levels, high school to teacher education. But if the institute program is designed to prepare instructors for a particular group of work assignments, select participants from corresponding school programs. In either case, include those in teacher education so that a supply of needed instructors can be made available later as needed.

Of major importance is the requirement that the participant is now teaching a unit or course in the new technology, or is expected to do so in the next school year. Information from follow-up studies suggests the obvious desirability of requiring also, an appropriate committment from the school administrator covering curriculum space or time, and budget for instructional materials and laboratory equipment.

Direct applicants to mail their forms to the institution nearest to them. Give the institute director authority to screen and to select participants, and request periodic reports from him.

7. Conduct a planning meeting with institute directors. Provide copies of comprehensive plans and review everyone's responsibilities. Study guide lines for institute programs and set dates for submitting checking-copies of programs. Cover all details of program operation, discuss any potential problems and examine alternate solutions, answer questions and provide any help needed.

8. Provide services of the coordinator by telephone or personal visit according to the nature of the service required or the problem encountered. Arrange for at least one visit to each institution during the program by one of the three staff members.

9. At the end of the institutes, conduct a summary meeting with directors and staff. Schedule a report from each director on his institute, request and collect suggestions and recommendations.

10. As part of the planning for institute evaluations, include an initial and final test, and participant-kept daily records and evaluations. Summaries of data thus obtained are of value to the institute director in making an assessment of the quality of his own program, and in determining final grades of his participants. Specify that these summaries be included in the director's report.

11. In the final report, include institute objectives, guide lines for program content, time allocations, institutions selected and institute dates, names of directors and instructors, names and

addresses of participants; assess the quality of the total institute program using summaries of examination scores and participant evaluations of instruction, laboratory work, seminar, and social-professional activities; assess the cooperation of industry using summaries of numbers of consultants and guest-lecturers, numbers and kinds of instructional aids and materials contributed, and number of guest-memberships in technical societies.

12. Evaluate the program using data obtained from a follow-up study providing for participant plans, and later progress and final reports. Summarize numbers of new and revised instructional programs, numbers of students served, improved and new laboratory facilities, and resulting technical and professional activities of participants. Compare achievement with estimates of existing needs, and make appropriate recommendations.

Foreword

To explore new ways of introducing the emerging technologies into schools, the Office of Education approved the 1965 Fluid Power Institutes as a pilot program in which a variety of procedures and evaluation devices were used experimentally to plan, conduct, and evaluate a multiple-institute program. From these, a coordinated program of planning, coordination and supervision, and evaluation was developed for further testing in the 1966 Fluid Power Institutes. This report describes in detail the various procedures and devices used, and includes illustrative examples helpful in planning multiple-institute programs for introducing other emerging technologies.

From these experiences it has become clear that the technical society representing the technology can be effective in planning, conducting, and evaluating the multiple-institute program; further, it is believed that such an agency uniquely facilitates the coordinated cooperation of the industry which is necessary to the success of any program having a similar objective. This is supported by the data reported in Chapter V, Section B, Cooperation of Industry, and attested to by participants, instructors, and directors.

Speaking for these, the author wishes to express appreciation to the Fluid Power Society, to the various companies which provided instructional materials and aids, and to the advisory committee members and guest-lecturers for their assistance and, equally if not more important, their continuing friendship.

Gerald Baysinger

CONTENTS

Page

Foreword

List of Tables iv

Chapter

I DESCRIPTION OF THE PROBLEM 1

Emergence of New Technologies 1
Role of Industry 3
Fluid Power 4
The 1965 Pilot Program 4
Purpose of the Study 5

II PLANNING FOR FLUID POWER INSTITUTES 6

The Administrative and Coordinating Agency 6
Preparation of the Proposal 6
Selection of Institutions 7
Selection and Appointment of Staff 9
Preparation of Comprehensive Plans 11
Publicity Media 12
Planning Conferences 12

III PREPARATION FOR FLUID POWER PROGRAMS 14

Physical Facilities 14
Program 22
Participants 25
Qualifications of Instructors 29

IV SUPERVISION AND COORDINATION 32

V EVALUATION 34

A. QUALITY OF INSTITUTE PROGRAMS 34

Instructional Content 34
Lecture-Demonstrations 40
Laboratory Experiences 41
Professional Seminar 47
Social-Professional Activities 50

B. COOPERATION OF INDUSTRY 52

Summer Institute Committees 52
Instructional Materials 53
Fluid Power Society 54

Page

C. FOLLOW-UP STUDY OF PARTICIPANTS 59

Initial Plans 59
Progress Report 59
Final Report 65

VI CONCLUSIONS AND RECOMMENDATIONS 70

APPENDIX*

A. Application for 1966 Summer Institutes 1

B. Program Planning, Coordination, and Evaluation 6

C. Announcement: 1966 Summer Institutes on Fluid Power 73

D. Typical Program: Fluid Power Institute V 76

E. Institute Participants: Names, Schools, Addresses

I Bradley University 90

II California State College at Los Angeles 92

III Hampton Institute 93

IV Trenton State College 95

V Wayne State University 96

F. Completed Seminar Assignments: Institute V 98

---

* Page numbers in the appendices are those shown in the upper right-hand corners.

LIST OF TABLES

Table		Page
1	Adequacy of Physical Facilities: Institute I	16
2	Adequacy of Physical Facilities: Institute II	17
3	Adequacy of Physical Facilities: Institute III	18
4	Adequacy of Physical Facilities: Institute IV	19
5	Adequacy of Physical Facilities: Institute V	20
6	Adequacy of Physical Facilities: Summary	21
7	Time Allocations of Program Activities in Hours	24
8	Participants by States	26
9	Participants: Type of Program	27
10	Participants: Level of Teaching	28
11	Evaluation of Technical-Professional Competencies of Instructors: Summary	30
12	Initial Test Data	36
13	Final Test Data	38
14	Individual Differences Between Initial and Final Test Scores	39
15	Participant Appraisals of Lecture-Demonstrations: Instructor	42
16	Participant Appraisals of Lecture-Demonstrations: Guest-Lecturers	43
17	Participant Appraisals of Lecture-Demonstrations: Instructors and Guest-Lecturers	44
18	Participant Participation and Appraisals of Laboratory Experiences	46
19	Number and Percentages of Seminar Assignments Completed	49
20	Percent of Participation in Social-Professional Activities	50

Table		Page
21	Summer Institute Committees: Numbers Involved	56
22	Summer Institute Committees: Time Spent	57
23	Instructional Material and Teaching Aids	58
24A	Educational Plans of Participants	60
24B	Educational Plans of Participants	61-62
25	Educational Plans: Progress	64
26	Educational Plans: Final Report	67
27	Comparison of Responses From 1965 and 1966 Institute Participants	68
28	Comparison of Accomplishments of 1965 and 1966 Institute Participants	69

CHAPTER I

DESCRIPTION OF THE PROBLEM

EMERGENCE OF NEW TECHNOLOGIES. The continuous improvement of manufacturing and production during the past twenty-five years is characterized by the term--Automation, but it is more than designing and building machines that will do the work of man; it includes science-based innovations in power generation and transmission, materials processing, synthesizing materials, construction and assembly; it includes sensing, measuring, decision-making, and more.

Further, applications are broad in scope and include transportation, housing and shelter, defense, communication, food, clothing, education, health, and even recreation.

Each group of innovative practices having accumulated its own body of knowledge and skill through research and development and performance data, becomes a technology. Meanwhile, practitioners of this new technology meet together to share their knowledge and experiences, and to work on common problems. These meetings soon require an organizational structure which results in a technical society. In 1965, there were 212 such organizations with a total membership of 2,277,503.

The result of these innovations and activities is soon apparent in the changing job requirements of the work force, and in shortages of trained personnel. In-plant training programs are developed and expanded but because of the science base which the new technologies have, such programs must also include related instruction in basic sciences. Meanwhile, the employer recognizes and accepts the responsibility for job training, but feels that basic education should not be a cost of production or service, and looks to the public school system for help.

Meanwhile, interaction and exchange develops between the new and developing technologies which results in more innovations and new applications with accompanying shortages of personnel. The process appears to be continuous with no end in sight, and has led some historians to call this the Technological Revolution.

Each new development, of course, calls for additional training of the present workforce and for trained replacements which places demands on schools for additional programs and for changes in present programs. For schools, this is difficult because few instructors now teaching are knowledgeable and competent in the new technology, and need additional training; next, textbooks suitable for school use have not yet been made available; and laboratories complete with training aids, and laboratory equipment including simulators, have not been designed nor built. Then too, the school can do no planning and make no committments until the new technology is operational in industry and has created a demand for trained manpower. Finally, the addition of only one new technology to an existing curriculum is costly in terms of space allocation and needed laboratories, and such expenditures may need to be deferred until additional funds can be obtained. Thus, the emergence of new technologies affects the schools too, and the rate of these developments outpaces the school's normal rate of change and adjustment.

ROLE OF INDUSTRY. Characteristic of the emerging technologies is the necessary hardware, as it is called, which is first conceived, designed and tested, and then produced. Much of this work is done at first by relatively small companies which may form a trade association so that solutions may be sought for such common problems as "standards", for example. In an emerging technology, such a trade group is "the industry."

If the technology is, in fact, new and not simply a refinement or extension of an existing one for which manpower needs can be met by in-plant training, member companies are made aware of the common problem of the need for educational programs through increased demands by customers for design application, installation, operation, and maintenance of the new hardware. As the costs of consumer services increase, the industry joins with its customers in looking to public education for a solution.

But because the technology is new, there are few, if any, competent teachers, and few schools are equipped with the necessary laboratories. Then too, the body of knowledge and experience has not been curriculumized for teaching purposes and because installation, operation, service and maintenance jobs are also new, job analyses have not been made which could be of help in organizing the necessary educational programs. Further, applications of new technologies are widespread and may cover many school systems and States thus requiring a nation-wide attack rather than local or State.

As a first step in the solution of the problem, the industry could conduct through its member companies an informal survey of customers to determine the extent of trained manpower needs in various job classifications, and to obtain opinions on the adequacy of present and available educational opportunities.

If the results of such a survey seem to warrant action, then the industry with a promise of cooperation could present the problem to the Office of Education.

FLUID POWER. Like other new technologies, Fluid Power has a science base, and emerged during the past twenty-five years; its practioners formed a technical society; its industry formed a trade organization; within the last two years, Fluidics has been a new development in Fluid Power for sensing, sampling, process control, material handling, and other applications; the National Fluid Power Association conducted a national survey in 1963 to document manpower needs; and the Fluid Power Society presented the problem to the Office of Education in 1965.

Meanwhile, the Industry provided the funds necessary to sponsor a summer institute in FLUID POWER for teacher-educators as a first step in introducing the technology to teacher education, and to provide a cadre of institute directors who may be needed later.

Finally, the Office of Education contracted with the FLUID POWER Society for summer institutes conducted in 1965 in which 168 teachers participated.

THE 1965 PILOT PROGRAM. With the Fluid Power Society serving as prime contractor, seven summer institutes in Fluid Power were conducted in 1965; these were supported by a grant from the Office of Education with the stated objective of developing and evaluating a program which could be used for introducing into the school system other new and emerging technologies.

The program was, therefore, conceived and planned as experimental and exploratory, and included various evaluation devices to test the many aspects of the total activity. Objective data and judgement based upon experience were used to select the most productive of the many and extensive procedures and techniques, and those were reported with a recommendation for further testing. Approval was then given to conduct five institutes in the summer of 1966 to test these selected procedures. Complete descriptions of the planning, operation, coordination, and evaluation including evaluation instruments are reported in "The Fluid Power Institutes--A Pilot Program for Introducing Emerging Technologies," Vocational and Technical Education Grant Number OE-5-85-039.

PURPOSE OF THE STUDY. Given a new and emerging technology having a science base, an industry which has previously documented both manpower shortages and absence of necessary educational programs through informal surveys and which has demonstrated a willingness to cooperate, and a professional society committed to the encouragement and development of educational programs in the new technology, the purpose of the study is to select and test procedures from the Conclusion and Recommendations of the 1965 Pilot Program for planning, preparing for, conducting, coordinating and supervising, and evaluating and reporting a multiple-institute program of summer institutes for preparing teachers in the new technology.

CHAPTER II

PLANNING FOR FLUID POWER INSTITUTES

THE ADMINISTRATIVE AND COORDINATING AGENCY. The Fluid Power Society was incorporated in May 1960 as a non-profit technical and educational organization. The management of the Society is vested in a Board of Directors which is elected annually by the membership, and a House of Delegates in which each chapter has proportional representation. Officers, elected annually, include a president, three vice presidents, and treasurer; and a full-time executive vice president and secretary.

The Society consists at present of 48 chapters; of this number, two are located in Canada, three in Australia, and two in England. Each chapter plans and conducts educational programs for its members according to various specializations represented. The Society co-sponsors national conferences and seminars, cooperates with other technical societies, and holds memberships in the American Standards Association and the Joint Industry Council.

PREPARATION OF THE PROPOSAL. Because the rate of change in industry and science has out-paced the rate of change in school programs, Federal funds were made available for research and development. Of the many programs conducted, the summer institute has been particularly effective in introducing innovations in teaching strategy and curriculum content. Such programs, for the most part, have been planned and conducted by individual institutions. For these, guide lines provided by the Office of Education specified program objectives but each institution was permitted some individualization in content and method, and there were few opportunities for coordination between the various institutions offering an institute in the same curriculum area.

For Fluid Power, on the other hand, there is an interested technical society with an executive officer having previous experience as Director of Field Services for a state university who could plan, coordinate, and service a multi-summer institute program.

Accordingly, the Fluid Power Society accepted the responsibility of prime contractor for the Summer Institutes in Fluid Power, and the Executive Vice President and Secretary prepared the proposal with the assistance and encouragement of staff members in the Office of Education. To describe the program and to compile a budget within the funds available, interested institutions were first asked to submit an application including a tentative budget; these were then combined into one proposal. A copy of the institutional application prepared by the Fluid Power Society appears in Appendix A.

SELECTION OF INSTITUTIONS. Application blanks were mailed to all institutions which are known to the Fluid Power Society through personal or mail contacts as having educational programs at the teacher-education level or which have a strong interest in establishing such programs. Those which have two or four-year technology programs without teacher-education or engineering colleges were not invited to make applications.

Funds tentatively allocated to Fluid Power Institutes limited the number to be conducted at five. Criteria for selection of these were:

1. A 1964 Summer Institute participant, or an assistant director of a 1965 Summer Institute, was available to direct the program.

2. An instructor with both technical and professional competencies was available.
3. The institution could provide necessary facilities for lecture-demonstrations and laboratory work, and for group study during the evenings and on weekends.
4. Living accomodations including dormitory, food service, and campus parking were available.
5. The institution was so located that field trips could be made to observe various industrial applications of Fluid Power.
6. Various social and professional activities were available for scheduling during weekends and holidays.
7. The institution was so located that technical personnel in the Fluid Power industry were nearby and readily available to serve as members of an advisory committee and as guest lecturers.
8. The institution was at a distance from others so that it might service a geographical area.
9. The institution was in an area in which there was a concentration of one or more commercial applications of Fluid Power such as aero-space, agriculture, marine, mining, manufacture, and others.

As a result of careful study and evaluation of each application, the following institutions were selected:

1. Bradley University -- Illinois
2. California State College -- Los Angeles
3. Hampton Institute -- Virginia
4. Trenton State College -- New Jersey

5. Wayne State University -- Michigan

SELECTION AND APPOINTMENT OF STAFF. Needed for planning, coordinating and supervising, and evaluating the multi-institute program were a small staff and an evaluation committee.

Representing the prime contractor, Mr. Theodore Pearce, Executive Vice President and Secretary, logically became the Principal Investigator responsible to the Office of Education for the various obligations and responsibilities which such a position necessarily entails.

For overall planning of the Institutes and for conducting and reporting the evaluation, the Principal Investigator selected and appointed Gerald Baysinger, Associate Professor of Industrial Education, Wayne State University, who had previously served as Director of the first Summer Institute in 1964, Director of two Summer Institutes in 1965, chairman of the Council for Fluid Power Education, chairman of the Vocational and Technical Education Committee of the Fluid Power Society, and author of the final report of the 1965 Institutes.

To coordinate and supervise activities, Mr. Fred Lamb was selected and appointed; he is an instructor in Fluid Power at Flint Community College, was a participant in the 1964 Institute, and served as coordinator for the 1965 Institutes. Mr. Lamb is now Chairman of his Department.

For the Evaluation Committee, and after consultation with staff members, the Principal Investigator selected as Chairmen, Dr. Robert Worthington, Assistant Commissioner for Vocational Education, New Jersey, who had previously served as Chairman of the Participant

Selection Committee for the 1964 Institute, and as Chairman of the Evaluation Committee for the 1965 Institutes. By thus making available to the Committee Dr. Worthington's previous experience, it was considered advantageous to select as committee members those who had not previously served in such a capacity so that others might become more knowledgeable and interested in advancing Fluid Power education. Then too, it was felt that the use of the entire 1965 Evaluation Committee might inadvertantly introduce bias for or against certain procedures which the study is designed to evaluate. Further, it was considered desirable to select as many members as possible from the immediate area so as to minimize travel and related costs of meeting. Those selected were invited by letter to serve on the Committee, and all accepted:

Evaluation Committee

Chairman:	Dr. Robert Worthington Assistant Commissioner for Vocational Education Trenton, New Jersey
Members:	Professor Joseph P. Arnold Purdue University
	George E. Carlson Minnesota Rubber Co.
	Warren Koerner Director of Technical Education Chicago Public Schools
	John J. Pippenger Racine Hydraulics Development Corporation
	Dr. Victor Spathelf, President Ferris State College

Edwin Taibl
Milwaukee Institute of Technology

Carl Turnquist
Director of Vocational Education
Detroit Public Schools

Consultant:	Howard Hogan Arlington, Virginia
Ex-Officio:	Gerald Baysinger Wayne State University
	Fred Lamb Flint Community College
	Theodore Pearce Fluid Power Society

It will be noted that industry is represented by two members, with other representation divided among various educational levels and administrative responsibilities.

PREPARATION OF COMPREHENSIVE PLANS. For the 1965 Institutes, the instructional program was planned by the institute directors as a group, working under the direction of the Coordinator; and the evaluation and data collecting instruments were planned by the Evaluation Committee working from materials provided by a consultant. As consequences, the coordination of institute activities and evaluation procedures often became complex and difficult, and the tabulation, interpretation and reporting of data as well as the form and content of the final report became extensive and time-consuming activities.

Based upon this experience, the Staff of the 1966 Institutes first carefully reviewed the findings and recommendations of the previous institute evaluation, and then prepared a 65-page plan for use in program planning, coordination and supervision, and evaluation including an outline of the final report. As such, the plan is comprehensive for it includes all activities, and functional for it provides the necessary integration of these activities; finally, it serves as a communication device ennabling each committee member, director, instructor, as well as institute staff members, to know these inter-relationships, to appreciate the responsibilities of others, and to cooperate in carrying out various assignments according to specifications.

The comprehensive plans were duplicated for use, and each staff member, director and instructor, and member of the Education Committee was provided copies. A copy may be found in Appendix B.

PUBLICITY MEDIA. A minimum budget for the Institutes precluded the printing of announcements which has become an established practice in summer institute administration, but provided for a small advertisement in School Shop Magazine and mimeographed announcements. The Fluid Power Society mailed copies to those requesting applications, and institute directors mailed copies to interested individuals and to various schools and school systems within the service area of their institutions. In addition, announcements were mailed to each Director of Vocational Education for the various States including the Virgin Islands, with a covering letter recommending that the application be forwarded to the head teacher trainer.

Announcements were duplicated on stationery of the Fluid Power Society. A copy is shown in Appendix C.

PLANNING CONFERENCE. On April 15 and 16, the institute directors and staff members met in Milwaukee. Copies of "Program Planning, Coordination, and Evaluation" were provided, and the material was reviewed so that directors would have an overall picture of the multi-institute project. Then, responsibilities of the director were examined and discussed in detail, and the importance of accuracy in reporting and reporting dates were stressed. Next, dates were established for visits to each institution by the coordinator, and for submission of working copies of instructional programs. Finally, the Principal Investigator reported on progress of institutional contracts, reviewed other administrative details, and answered questions.

Because of the amount of work which the planning of one intensive summer institute entails, it was expected that three days would be required for planning with the directors; instead the work was completed in one evening and a part of the second day. Early completion of planning and other responsibilities was appreciated and judged to be the result of thorough pre-planning.

One institute director was not able to attend the conference because of a death in his family. But the following week, the Coordinator visited the director and worked with him individually.

CHAPTER III

PREPARATION FOR FLUID POWER PROGRAMS

PHYSICAL FACILITIES. Previous to the starting date for the institute, the Coordinator visited the institution and, with the Director, inspected the physical facilities using a comprehensive checklist prepared for that purpose. See page 17 Appendix B.

The purpose of the inspection was not to obtain a rating of the facilities of various institutions, but to identify any problems and to explore alternate arrangements with the Director so that the quality of the physical facilities would be maximized. The Coordinator was well qualified to do this, for he had been a participant himself in the first Institute in 1964, had visited all of the institutions which offered the 1965 institutes, and had developed his own Fluid Power Laboratory at Flint Community College.

The completed checklists were then summarized by institution, and the Coordinator's evaluation of each is shown in Tables 1-2-3-4-5. Table 6 summarizes the evaluations for all institutions.

It will be noted that only one institution received an evaluation of a facility of (3) -- Adequate, that all other evaluations were (1) -- Excellent and (2) -- Good, and that Institute V was rated (1) -- Excellent on all five facilities. This particular institution has a new campus and, within the last year, had added a well-planned and well-equipped Fluid Power Laboratory and lecture facility.

As shown in Table 6, the mean rating for Living Accomodations was (2) -- Good; Foods Service and Facilities for Lecture-Demonstration were (1.6) -- Good to Excellent, and Laboratory and Group Study Facilities had a mean rating of (1.4) -- Excellent to Good. The mean rating for all five facilities at all five institutions was (1.6) -- Good to Excellent.

TABLE 1

ADEQUACY OF PHYSICAL FACILITIES: INSTITUTE I

Facility	Evaluation				
	1	2	3	4	5
1. Living Accommodations			X		
2. Food Service	X				
3. Lecture-Demonstration	X				
4. Laboratory		X			
5. Group Study	X				
Overall Evaluation		1.6			

Code:
1 - Excellent
2 - Good
3 - Adequate
4 - Acceptable
5 - Some Problems

TABLE 2

ADEQUACY OF PHYSICAL FACILITIES: INSTITUTE II

Facility	Evaluation				
	1	2	3	4	5
1. Living Accommodations		X			
2. Food Service		X			
3. Lecture-Demonstration		X			
4. Laboratory		X			
5. Group Study		X			
Overall Evaluation		2.0			

Code: 1 - Excellent
2 - Good
3 - Adequate
4 - Acceptable
5 - Some Problems

TABLE 3

ADEQUACY OF PHYSICAL FACILITIES: INSTITUTE III

Facility	Evaluation				
	1	2	3	4	5
1. Living Accommodations		X			
2. Food Service		X			
3. Lecture-Demonstration		X			
4. Laboratory	X				
5. Group Study	X				
Overall Evaluation		1.6			

Code: 1 - Excellent
2 - Good
3 - Adequate
4 - Acceptable
5 - Some Problems

TABLE 4

ADEQUACY OF PHYSICAL FACILITIES: INSTITUTE IV

Facility	Evaluation				
	1	2	3	4	5
1. Living Accommodations		X			
2. Food Service		X			
3. Lecture-Demonstration		X			
4. Laboratory	X				
5. Group Study		X			
Overall Evaluation		1.8			

Code: 1 - Excellent
2 - Good
3 - Adequate
4 - Acceptable
5 - Some Problems

TABLE 5

ADEQUACY OF PHYSICAL FACILITIES: INSTITUTE V

Facility	Evaluation				
	1	2	3	4	5
1. Living Accommodations	X				
2. Food Service	X				
3. Lecture-Demonstration	X				
4. Laboratory	X				
5. Group Study	X				
Overall Evaluation	1.0				

Code: 1 - Excellent
2 - Good
3 - Adequate
4 - Acceptable
5 - Some Problems

TABLE 6

ADEQUACY OF PHYSICAL FACILITIES: SUMMARY

Facility	Mean Evaluation				
	1	2	3	4	5
1. Living Accommodations		2.0			
2. Food Service		1.6			
3. Lecture-Demonstration		1.6			
4. Laboratory	1.4				
5. Group Study	1.4				
Overall Evaluation -- Mean		1.6			

Code: 1 - Excellent
2 - Good
3 - Adequate
4 - Acceptable
5 - Some Problems

PROGRAM. From previous experience, the summer institute programs which were judged to be most successful were those which provided three distinct groups of activities: instructional program, professional seminar, and social-professional activities. At the planning conference for institute directors, it was pointed out that the program for each institute would necessarily differ from others. Guest-lecturers for specific lecture topics may or may not be available; laboratory facilities would vary and thus determine number and breadth and depth of laboratory experiences; the nature of local industry would determine kind and number of field trips that could be planned; and cultural, campus, other activities of interest, would of course be those available locally.

Each institute director, therefore, was asked to plan his own program following the guide lines provided in "Program Planning, Coordination, and Evaluation", Appendix B; to submit a working copy to the Coordinator for review and suggestions; and to duplicate the revised and approved copy for distribution to participants.

The programs planned by the institute directors and approved by the Coordinator, thus covered eleven main topics in hydraulics and eight main topics in pneumatics as specified in the guide lines; they included provision for the necessary and supplemental laboratory experiences; they included planned field trips to local industries to observe various applications of fluid power; they provided for professional seminars which included preparation of course outlines, lists of instructional materials including textbooks and references, lists of laboratory equipment and supplies, and laboratory layouts; and they included programs of social-professional activities. Finally, they met substantially the guide lines for time allocations established at 190 clock hours but not including social-professional activities.

It was planned originally to include copies of all programs in this report but because five reports together would be bulky and somewhat repetitive it was decided to show only one as an example: see Appendix D.

Recommended time allocations for each of the five activities are shown in Table 7 together with the time allocations for each of the institute programs. From the data summarized, it will be noted that the programs for all institutes met or exceeded time allocation requirements with two exceptions: Institute IV provided for 48 hours of laboratory work instead of 50, but balanced this shortage of 2 hours with an additional 14 hours of lecture-demonstrations; Institute III provided 19 hours for Seminar instead of 24, but used the time for additional lecture-demonstrations in pneumatics so that an introduction could be given to Fluidics, a new development in Fluid Power, and not included in the program guide lines for instructional content. Both of these modifications were previously reviewed and approved by the Coordinator.

Well-planned and individualized programs were thus made possible by the use of program guide lines, planning conference, and review and approval of working copies by the Coordinator.

TABLE 7

TIME ALLOCATIONS OF
PROGRAM ACTIVITIES IN HOURS

ACTIVITY	REQUIRED	INSTITUTE				
		I	II	III	IV	V
Lecture-Demonstration						
Hydraulics	60	60	60	62	61	59.5
Pneumatics	40	40	40	48	53	39
Laboratory Work	50	51	50	53	48	50.5
Field Trips	16	16	30	18	16	16
Seminar	24	24	23	18.5	24	30
Social-Professional Activities	-	17	30	7.5	32	18
Totals	190	208	233	207	234	213

PARTICIPANTS. Institute application forms were provided by both the Fluid Power Society and the institute directors, but were returned to the institution preferred by the applicant. Upon receiving these, the directors checked eligibility of each applicant, and notified each by letter of the decision made. The Institute Coordinator, at the time of his visit to each institution, then examined the applications, and verified to the Fluid Power Society by letter that participants accepted met the criteria for eligibility.

For each institute, the names of participants, schools, and school addresses are shown in Appendix F.

Participants in the five institutes represented 25 different States as shown in Table 8. Those with the largest representation were California -- 5, Illinois -- 6, Michigan -- 7, New Jersey -- 6, and Virginia -- 10; these were, as might be expected, the States in which institutes were offered. It is interesting to note that participants in the seven institutes of 1965, represented 35 States which is the same ratio 1:5, as the 1966 representation. To provide minimum service to the 48 States of continental United States, then, a minimum of ten institutes would be required.

The level of teaching by participants, as indicated by type of program, is also of interest. These have been tabulated in Table 9, and reveal that the largest number of participants, 35, were teaching in high schools. In Table 10, totals are shown for various school levels: Secondary, Post-Secondary, and Teacher Education. It will be noted that more than one-half of the participants were teaching at the secondary school level either in high schools or vocational schools. Although criteria (for selecting participants)

TABLE 8

PARTICIPANTS BY STATES

State	Number	State	Number
Arkansas*	2	Nevada	1
Connecticut	1	New Jersey	6
District of Columbia*	2	New York	3
California	5	North Carolina	2
Florida	1	Ohio	3
Georgia	1	Pennsylvania*	1
Illinois	6	South Carolina*	1
Indiana	3	Virgin Islands*	1
Kansas*	1	Virginia	10
Louisianna	2	Wisconsin	2
Maine	1	Graduate Student (New Jersey)	1
Michigan	7	Canada	6
Minnesota	3	Nigeria (Virginia)	1
Mississippi	1		
Nebraska*	1	TOTALS	75

* Additional States Not Represented In The 1965 Fluid Power Institutes

TABLE 9

PARTICIPANTS: TYPE OF PROGRAM

Type of Program	Institute					Total
	I	II	III	IV	V	
High School	10	10	4	8	3	35
Vocational School	3	3	-	2	1	9
Community - Junior College	-	-	-	1	2	3
Technical Institute	1	-	2	1	3	7
Four-Year Technology	2	3	1	1	-	7
Teacher Education	-	-	4	3	-	7
Other	4	1	-	-	2	7
Totals	20	17	11	16	11	75

TABLE 10

PARTICIPANTS: LEVEL OF TEACHING

School Level	Institute					Total
	I	II	III	IV	V	
Secondary	13	13	4	10	4	44
Post Secondary	3	3	3	3	5	17
Teacher Education	0	0	4	3	0	7
Other	4	1	0	0	2	7
Totals	20	17	11	16	11	75

did not include quotas for various school levels, the high percentage of secondary school teachers selected is believed to be a normal and desirable outcome because, first, there are more teachers at the secondary level and, second, education in Fluid Power like other new technologies should begin in the secondary school.

It is of interest also to note that the introductory program was so designed as to serve the needs of teachers at all levels, and that the Fluid Power program was not only multi-institute but multi-level in concept.

QUALIFICATIONS OF INSTRUCTORS. At the planning conference held in April in Milwaukee, directors were given additional copies of a form, "Personal Information: Instructors", and were asked to have these completed by their instructors and to return them to the Coordinator prior to the opening of their institutes. A copy of this form appears in Appendix B, pages 31-35.

Members of the Evaluation Committee representing the Fluid Power industry and also the Education Committee of the Fluid Power Society, examined the completed forms for the seven instructors, and made judgements on each of the five classifications of personal information using a special form prepared for that purpose which is shown in Appendix B, page 30. Individual judgements on each instructor were then combined into one evaluation. For the seven instructors, these evaluations are shown in Table 11.

It will be noted that four instructors were judged to be excellent and three, good; none were rated below good.

The combined judgements of those knowledgeable in Fluid Power

TABLE 11

EVALUATION OF TECHNICAL-PROFESSIONAL COMPETENCIES OF INSTRUCTORS: SUMMARY

INSTRUCTOR	EVALUATION				
	1	2	3	4	5
A	X				
B	X				
C		X			
D		X			
E	X				
F	X				
G		X			

Code: 1. Excellent
2. Good
3. Adequate
4. Acceptable
5. Inadequate for Assignment

confirmed the original judgements of the Principal Investigator who earlier had used biographical reports submitted by directors as a part of their applications for institute programs. Had they been otherwise, the Coordinator was prepared to discuss changes in institute personnel with directors.

Not shown in Table 11, is previous participation in Fluid Power Institutes. It can be reported, however, that of the seven instructors, three had been participants in previous institutes, and two had been part of the instructional team of the first institute in 1964. In addition, four of the five directors were participants in the first institute. These facts are mentioned to supplement the data in Table 11.

CHAPTER IV

SUPERVISION AND COORDINATION

The Fluid Power Institutes, a multi-institute program, necessarily requires of the prime contractor two additional services: one, sub-contracting with selected institutions to offer institutes and the accounting of both institutional and prime-contractor costs as provided in approved budgets; and two, field work consisting of supervision and coordination to insure that institutional facilities are adequate, instructional staffs are competent, individual programs are thoroughly and well-planned, participants meet pre-established criteria, institute programs are well-conducted, directors collect and submit necessary reports and evaluation data, and stand-by and immediate assistance is available for any emergency that may arise.

Responsibility for details of budgets and accounting was assumed by the Chief Investigator, Theodore Pearce, and is not included in this report. Responsibility for supervision and coordination was assigned to the Institute Coordinator, as described earlier, who reported directly to the Chief Investigator.

The Institute Coordinator, Mr. Fred Lamb, was well-qualified to assume those responsibilities: he has a number of years teaching experience in Fluid Power at Flint Community College in Flint, Michigan; he was a participant in the first Fluid Power Institute in 1964 and sensitive to the needs, interests, and emerging concerns of participants in such programs; he served as Coordinator of the 1965 Institutes and had previously visited and was well acquainted with four of the five institutions; he knew and had previously worked with all five directors and and six of the seven instructors; finally, he was acceptable to the directors as a result of the quality of his own participation in the 1964 Institute in which he was rated by participants, using the paired-comparison technique, in the upper ten percent of a highly-selected group.

Accordingly, Mr. Lamb conducted the planning conference with the directors as previously described, reviewed and made various suggestions for improving instructional programs, visited each institution and inspected facilities using a checklist, at each institution he visited and observed selected class meetings, checked and validated participant selection at each institution, served as consultant upon the request of the director either in person or by mail or telephone, followed through and collected from directors the various reports and evaluation data.

In performing these activities, he was accorded a noticeable confidence, respect, and continuing friendship of the directors and instructors with whom he worked which can be offered as evidence of the successful completion of supervisory and coordination responsibilities.

CHAPTER V

EVALUATION

A. QUALITY OF INSTITUTE PROGRAMS

INSTRUCTIONAL CONTENT. In a multi-institute program, assurance seems to be needed that the various individual programs included the instructional content as specified; this assurance would be supplementary to the reviewand approval of each instructional program by the Institute Coordinator as described in Chapter III, and could be obtained from participant performance on written examinations.

Such written examinations could also provide some measure of the quality of instruction if comparable data were avilable, but for Fluid Power Institutes no such data existed for the 1966 programs. Comparison of test data between various institutes could be made but results would be conditioned by other variables such as the participant's previous course work in sciences and, possibly, Engineering as well as his industrial or military experience, and teaching experience. For this reason, scores on examinations may be noted but no attempt will be made to use them to describe or compare quality of instruction.

The written examinations used consisted of initial and final tests of fifty multiple-response items each. Fifty-seven items were those used in the final examination for the 1965 Institutes, and had been validated by a difference-between-proportions technique. To obtain a total of 100 times, additional items were prepared and used by the Institute Coordinator in the Spring Term of 1966; these were then validated by difference between proportions.

All test items were then grouped according to main topic of the required instructional content, and divided by random sampling into two parts of fifty items each. One of the parts was chosen by a flip of a coin to be the initial examination; the other became the final examination. Thus, both examinations were comparable in difficulty, and each sampled all of the main topics in the instructional outline.

Copies of the initial examination were mailed to each institute director so as to arrive several days before his program was scheduled to start. Directions were to give the examination on the first day of the program and before any instruction was given, and to return the examinations uncorrected. In the same way, copies of the final examination were mailed to each director to arrive within the last two days of his program. For the final examination, directions were to give the examination after all instruction was completed, and to return all copies uncorrected.

Using prepared answer keys, the Institute Coordinator corrected all initial and final examinations. For these, the mean scores and standard deviations for each Institute and for all Institutes are shown in Tables 12 and 13.

In examining the mean scores of the initial examination, it should be remembered that one of the participant selection criteria was that the participant is now, or will be in the fall of 1966, teaching a unit or course in Fluid Power. Mean scores for each Institute reveal some knowledge of Fluid Power, and range from a low of 17.5 to a high of 28.8. For all institutes, the mean score was 26.4 correct or a little more than one-half of the fifty test items.

For the standard deviation of initial test scores, the range

TABLE 12

INITIAL TEST DATA

INSTITUTE	NUMBER	MEAN SCORE[1]	STANDARD DEVIATION[2]
I	20	28.6	7.5
II	11	27.3	7.4
III	17	17.5	4.7
IV	11	21.2	10.2
V	16	28.8	7.1
ALL INSTITUTES	75	26.4	8.7

[1] Mean Score is the arithmetical average and is obtained by adding all scores and then dividing the sum by the number of such scores.

[2] Standard Deviation is a convenient statistical measure which describes the spread of scores about the Mean Score. One standard deviation unit above and below the mean includes approximately 68% of all scores. Thus, for the Initial Test, 68% of the scores were between 26.4 plus and minus 8.7 or 18 and 35.

was 4.7 to 10.2; for all participants, the standard deviation was 8.7.

It will be noted that Institute III reported the lowest mean score -- 17.5 and the smallest standard deviation -- 4.7. The institution offering this institute is in an area of the United States which has not been previously served by Fluid Power programs; hence, teachers would have less information than those in other sections; also, that lack of information was general among all teachers and not confined to those teaching at any-one level.

On the other hand, the largest standard deviation -- 10.2 was reported for Institute IV indicating that these participants included some who were teaching in post-secondary schools and were quite knowledgeable, and others who were planning to introduce a course in the fall and who knew very little about the subject. It will be recalled that the Fluid Power Institute was planned as a multi-level program and the need and desirability for doing so would seem to be affirmed by the range of mean scores and standard deviations.

Table 13 lists the mean scores and standard deviations of final examinations for each institute and for all institutes. It will be noted that mean scores increased from 26.4 to 43.4 on a 50-item examination, and that the spread of scores as indicated by the standard deviation decreased from 8.7 to 4.5. Thus, it is evident that participants' knowledge of Fluid Power was increased, and that the multi-level program is feasible as indicated by the decrease of almost one-half in the standard deviation. While these figures are somewhat impressive and may reveal the high quality of instruction and laboratory work, there are no data available which could be used

TABLE 13

FINAL TEST DATA

INSTITUTE	NUMBER	MEAN SCORE	STANDARD DEVIATION
I	20	40.30	1.34
II	11	44.30	6.20
III	17	34.35	6.12
IV	11	38.36	5.50
V	16	43.25	3.60
ALL INSTITUTES	75	43.4	4.5

TABLE 14

INDIVIDUAL DIFFERENCES BETWEEN INITIAL AND FINAL TEST SCORES

INSTITUTE	NUMBER	MEAN SCORE	STANDARD DEVIATION
I	20	13.5	7.1
II	11	10.9	6.4
III	17	11.0	4.9
IV	11	16.9	8.5
V	16	14.1	6.2
ALL INSTITUTES	75	12.9	6.88

for purposes of comparison.

Data reported in Table 14 was obtained by subtracting the score of the initial examination from that of the final examination for each participant. It will be noted that the mean difference, or increase in number correct, for all participants was 12.9 and that the standard deviation or spread was 6.88. These parameters are significant at the .95 confidence level.

As pointed out in the discussion of data in Table 13, there are no other data available which could be used for comparison to ennable the making of judgements on quality of the programs. The test data as reported in Tables 12, 13, and 14 would seem, however, to confirm that all specified main topics were included in the instructional programs as reported in the plans of the various institute directors.

LECTURE-DEMONSTRATIONS. To obtain a measure of quality of lecture-demonstrations given by various instructors and guest lecturers at each of the five institutes, participants were provided with a daily log to record pertinent information which would be helpful to them in completing Seminar assignments, and to record their appraisals of each of the lecture-demonstrations. These were collected by the institute directors, and later counted, assigned scale values, and averaged arithmetically. For procedures and forms used, see Appendix B, pages 37, 38, and 39.

Mean appraisals by participants of the lecture-demonstrations given by instructors are shown in Table 15, and range from 1.08 to 1.6 with (1) representing "Thorough", and (2)--"Some Questions".

The mean appraisal of all instructors by all participants was 1.2.

Mean appraisals of guest-lecturers are shown in Table 16, and range from 1.03 to 1.2 with a mean for all guest-lecturers of 1.12.

For both instructors and guest-lecturers, mean appraisals are shown in Table 17, and range from 1.09 to 1.34 with a mean for all instruction of 1.20.

From the data thus reported, it is of interest to note that the quality of classroom performance of instructors parallels the judgements of their technical and professional competencies as made earlier by a sub-committee of industrial specialists, and reported in Table 11. Surprising, however, was the consistently high appraisals of guest-lecturers from industry whose work assignments normally do not include teaching. It should be pointed out, however, that after the 1965 Institutes the directors and Coordinator knew many industrial personnel and their potential for instruction, and made good selections.

From a study of participant appraisals of the quality of all lecture-demonstrations, it can be assumed that the instruction was thorough and understandable and, as one member of the Evaluation Committee said in reviewing the data, "I wish that all college subjects were as well-taught."

LABORATORY EXPERIENCES. In addition to the Daily Log for Lecture-Demonstrations, participants were provided copies of a similar form for recording and evaluating laboratory experiences. At the end of each Institute, these were collected, summarized, and tabulated. Instructions, Daily Log: Laboratory Experiences, and Tally Sheet may be found in Appendix B, pages 41-44.

TABLE 15

PARTICIPANT APPRAISALS OF LECTURE-DEMONSTRATIONS: INSTRUCTOR

Institute	Sum of Totals	Sum of Products	Mean Appraisals
I	318	342	1.08
II	220	264	1.2
III	442	526	1.2
IV	738	879	1.19
V	138	221	1.6
TOTAL -- All Institutes	1856	2232	1.2

CODE:

1. Thorough
2. Some Questions
3. Not Clear

TABLE 16

PARTICIPANT APPRAISALS OF LECTURE-DEMONSTRATIONS: GUEST-LECTURERS

Institute	Sum of Totals	Sum of Products	Mean Appraisals
I	237	246	1.03
II	202	229	1.1
III	211	248	1.2
IV	208	239	1.15
V	176	200	1.15
TOTAL -- All Institutes	1034	1162	1.12

CODE:

1. Thorough
2. Some Questions
3. Not Clear

TABLE 17

PARTICIPANT APPRAISALS OF LECTURE-DEMONSTRATIONS: INSTRUCTORS AND GUEST-LECTURERS

Institute	Sum of Totals	Sum of Products	Mean Appraisals
I	535	588	1.09
II	422	493	1.17
III	653	774	1.18
IV	946	1185	1.25
V	314	421	1.34
TOTAL -- All Institutes	2870	3461	1.20

CODE:
1. Thorough
2. Some Questions
3. Not Clear

Shown in Table 18 are arithmetic means of participant appraisals, number of laboratory experiences, and time spent in hours. It will be noted that participant mean appraisals of the educational value of their own laboratory experiences ranged from 1.05 to 1.36 with a mean of 1.16 for all institutes. Thus, participants evaluated the selected laboratory experiences provided for them as having high educational value.

Next, the average number of laboratory experiences per participant ranged from 7.5 to 19.6 with a mean of 13.5 for all institutes. A careful re-examination of daily logs revealed that, for Institutes I and IV, participants had not listed such laboratory work as dis-assembly and assembly of various components but had reported only on their laboratory experiments in circuitry using training simulators. A check with institute directors later, confirmed that this was true and that the error was due to a misunderstanding of the intent and use of the Daily Logs.

Then too, the previous information about Fluid Power held by the various participants varied as shown by scores on the initial examination and reported in Table 12, and institute instructors were selective in making individual laboratory assignments; thus, if a participant was already familiar with a particular component, for example, he was not asked to disassemble and re-assemble one.

For these reasons, the range in average number of laboratory experiences is from a low of 7.5 to a high of 19.6; and for average hours spent, from 3.4 to 60.6. It will be recalled that in all programs 50 hours of scheduled time was allotted to laboratory work.

TABLE 18

PARTICIPANT PARTICIPATION AND APPRAISALS OF LABORATORY EXPERIENCES

nstitute	Education Value			Number of Participants	Number of Experiences	Mean	Number of Hours	Mean
	Products	Totals	Means					
I	235	196	1.2	20	196	9.8	676	3.4
III	362	332	1.1	17	332	19.6	1031	60.6
IV	86	82	1.05	11	82	7.5	65	5.9
V	321	277	1.16	16	277	17.3	353	22.1
II	168	124	1.36	11	124	11.3	281	25.5
OTAL- All Institutes	1172	1011	1.16	75	1011	13.5	2406	32.1

EDUCATIONAL VALUE

1 - High
2 - Some
3 - Little

The data, therefore, seems to indicate that laboratory experiences were planned and so assigned as to meet the needs of participants having a wide range of previous knowledge, and that these experiences were judged by them to have had high educational value.

PROFESSIONAL SEMINAR. So that a participant would be prepared upon his return to school to discuss plans for the introduction or expansion of Fluid Power Education with his departmental chairman or principal, the instructional program of each institute included a professional seminar in which procedures and techniques were reviewed for developing course outlines, selecting texts and references, selecting audio-visuals and other instructional aids, identifying and specifying needed laboratory facilities, and for planning a new laboratory or altering an existing one.

Participants were then grouped by type of school, and encouraged to develop the necessary plans. Much of this work was done during the evenings and weekends but laboratories were kept open so that participants could preview films, examine and evaluate various commercially-produced simulators, and check tool and equipment catalogs. And, of course, group-study facilities were available at each institution.

It is believed that the satisfactory completion of such planning is a valid indicator of a successful institute for the work involved obviously requires high interest in the subject, and a willingness to devote much time and effort over and above the normal work-study week.

To obtain the information needed for evaluation purposes, copies of a Daily Log were provided each participant; these were collected at the end of the institute by the director, and later summarized. A copy of the Daily Log and directions may be found in Appendix B, pages 45-47.

Number and percentages of seminar assignments completed by participants at each institute are shown in Table 19. It will be noted that one institute encouraged participants to complete four assignments; two institutes, five assignments; and two, six assignments. In addition, a total of 375 out of a possible 380 assignments were completed for a percentage of 99.

It is admittedly difficult to evaluate the quality of such planning, and copies of each would be too extensive to include in this report; copies of those of one institute, however, are shown in Appendix F as an illustration of the quality of the work completed. For this purpose, completed assignments were selected from the same institute for which the instructional program is also included in the Appendix, so that such details as discussion topics or group activities and time allocations might be examined in more detail.

It should be pointed out that seminar assignments were considered voluntary rather than requirements for college credit, and were suggested to participants as a desirable aid for introducing or expanding programs of Fluid Power in their own schools.

Based upon the high percentage of completion of seminar assignments, then, a conclusion that the seminar experiences were of high quality would seem to be justified.

TABLE 19

NUMBER AND PERCENTAGES OF SEMINAR ASSIGNMENTS COMPLETED

Number of Assignments	**Institute**					**Total**
	I	II	III	IV	V	
1						
2						
3						
4		17				68
5	19			16		175
6			11		11	132
Number of Participants	20	17	11	16	11	75
Percentage Completed	95	100	100	100	100	99%

SOCIAL-PROFESSIONAL ACTIVITIES. The program of each institute included planned activities for evenings, Fourth of July, and weekends. A typical program, see Appendix D, included trips to nearby points of historical interest, cultural institutions, and campus activities including a final luncheon or dinner meeting. Previous experience indicated that these group activities can build morale, stimulate interest, and engender friendships. Participation which, of course, is voluntary can be used as one indication of the quality of the institute program.

For records, participants were provided copies of a Daily Log. These were collected at the end of the program, and summarized. For copies of directions, Daily Log, and Tally Sheet see Appendix B, pages 48-51.

The percent of participation, and number of activities scheduled for each institute are shown in Table 20. The number of activities scheduled ranged from 3 to 9; for the total program the arithmetic mean was 6.2. Participation ranged from 100 to 61 percent; for the total program, participation was 83.2 percent.

In examining the data, it should be remembered that participation was entirely voluntary, that some participants lived within commuting distance of the institution and went home on weekends including the three-day Fourth of July weekend, and that some points of interest had been visited previously by participants particularly those who were graduates of the institution or who lived in or near the immediate area. With these points considered, the voluntary participation in social-professional activities would seem to indicate that program quality was maintained at a high level for all of the institutes.

TABLE 20

PERCENT OF PARTICIPATION IN SOCIAL-PROFESSIONAL ACTIVITIES

Institute	Activities Scheduled	Percent of Participation
I	7	90.5%
II	6	100%
III	3	84.9%
IV	9	76.0%
V	7	61.0%
Total	31 (Mean 6.2)	83.2%

B. COOPERATION OF INDUSTRY

For the purpose of evaluating and reporting, Industry is defined as member companies of the National Fluid Power Association, and chapters and individual members of the Fluid Power Society. In introducing a new technology into schools, the cooperation of industry is needed because much of the informational content has not been, as yet, curriculumized and printed in text books, but can only be obtained from knowledgeable people in the industry and from manuals, technical reports, catalogs, and other customer publications.

Then too, the extent of cooperation of industry is believed to be one measure of the need for educational programs in the new technology as pointed out in Chapter I.

For the Fluid Power Institutes, cooperation of industry was invited for five specific services: consultation, field trips, guest lecturers, instructional materials, and Fluid Power Society memberships and services. Copies of instructions to institute directors and forms for reporting data are included in Appendix B, pages 44 to 50.

SUMMER INSTITUTE COMMITTEES. In the program planning stage, each institute director invited industry personnel from the immediate area in which the institution was located, to serve on a Summer Institute Committee. With the Committee's help, he identified needed and available teaching aids, laboratory supplies, and hand tools; selected and made arrangements for field trips; and identified topics for which guest-lecturers would be advantageous, selected such guest-lecturers, and scheduled them in the program.

The numbers of industry personnel involved in these various activities are shown in Table 21. By institute, the number ranged from 19 to 29, and for all institutes the total was 115 different individuals.

The time spent on the various activities by industry personnel is shown in Table 22. For individual institutes, total hours ranged from 68 to 133, and for all institutes the total was 453 hours. It should be pointed out that this reported time does not include travel to and from the institution and, further, these services were provided at no cost to the institutes but represent a voluntary contribution by the individuals themselves or by the companies for which they work. No attempt was made to determine the dollar value of this service but it can be conservatively estimated at between 15 and 20 thousand dollars.

INSTRUCTIONAL MATERIALS. After institutions were selected, and during the planning period, letters were written by the Education Committee of the Fluid Power Society to various member companies of the National Fluid Power Association inviting them to send various publications and instructional devices to each of the institutes. Upon receiving these, institute directors responded with letters of acknowledgement and appreciation, and then tabulated items and numbers of each on a form prepared for that purpose. This information was then collected from directors, and summarized in Table 23.

By institute, the number of various items ranged from 848 to a high of 6007; of these, catalogs totalled 3791 with technical reports a close second with a total of 3427. The totals for all institutes were 11,258 or approximately 150 per participant. These, were of course, distributed to participants and later became a part of the room library at the participant's institution.

No attempt was made to obtain the cost of these items but some instructional devices are known to cost as much as $60. For the total contribution of industry, a conservative estimate is $50,000.

FLUID POWER SOCIETY. Before the end of each of the institutes, the Fluid Power Society sent guest membership blanks to directors who distributed these to participants. The locations of the various chapters were given, chapter programs were briefly described, copies of "Hydraulics and Pneumatics" and "Fluid Power International", monthly publications, were shown and examined. Guest membership blanks were then collected and mailed to the Fluid Power Society which, in turn, sent a membership lapel pin and card to each participant. The particular chapter preferred by the participant was then notified, and the participant was welcomed by the chapter and sent notices of all local and national meetings.

This was done in recognition of the importance to the teacher and instructor in a new technology of maintaining close relationships with industry.

In summary, the Fluid Power Industry has actively cooperated in the multi-institute program by providing consultative services, guest-lecturers, instructional materials, field experiences, and memberships in the technical society; the extent of this cooperation affirms the previously determined need for educational programs in Fluid Power; and the monetary value of services and materials provided is approximately equal to or in excess of the sums provided by other agencies.

TABLE 21

SUMMER INSTITUTE COMMITTEES
NUMBERS INVOLVED

Activity	Number of Members					Total
	I	II	III	IV	V	
Consultation	4	6	7	5	4	26
Field Trips	4	6	7	5	4	26
Guest Lecturers	11	11	15	13	13	63
Total	19	23	29	23	21	115

TABLE 22

SUMMER INSTITUTE COMMITTEES

TIME SPENT

Activity	Hours Spent					Total Hours
	I	II	III	IV	V	
Consultation	12	25	50	25	12	124
Field Trips	12	18	23	16	8	77
Guest Lecturers	44	44	60	52	52	252
Total Hours	68	87	133	93	72	453

TABLE 23

INSTRUCTIONAL MATERIAL AND TEACHING AIDS

Item	Number Received					Total
	I	II	III	IV	V	
Catalogs	309	2104	295	783	300	3791
Manuals	316	595	121	243	93	1363
Technical Reports	507	2175	297	383	65	3427
Bulletins	363	855	154	233	260	1865
Instructional Devices	109	253	66	144	110	682
Books	25	25	25	28	20	125
Totals	1629	6007	958	1814	848	11,258
Number Per Participant	150					

C. FOLLOW-UP STUDY OF PARTICIPANTS

INITIAL PLANS. During the last week of each institute program, the directors distributed to participants copies of a check list: Educational Plans For Next Year, and of a covering letter from the Institute Coordinator which briefly explained the follow-up study and asked for the participant's cooperation. A copy of each of these appears in Appendix B, pages 59 to 63.

The check list itemized 19 activities which a participant might choose to do upon his return to his teaching assignment at the end of the Summer. After participants completed the check lists, directors collected them and mailed them to the Coordinator.

Table 24A is a summary of the information thus collected. Activities are identified by the number of the activity as it appears in the check list; and the numbers of participants who elected to do each activity are reported for each institute.

The average number of activities selected ranged from 3 to 7; for all institutes, the average was 5.

In Table 24B, the activities are described, identified by item number, and arranged in descending order. The four most frequently selected plans are of particular interest for they reflect the main purpose of the institute program which was, of course, to introduce Fluid Power into educational programs.

PROGRESS REPORT. Near the end of the first semester of the school year, each participant was sent a form for reporting progress of his educational plans, a covering letter, and a self-addressed and stamped return envelope. See Appendix B, pages 64 to 67. The progress re-

TABLE 24A

EDUCATIONAL PLANS OF PARTICIPANTS

Activity	Institute					Total
	I	II	III	IV	V	
1	4	11	4	8	7	34
2	6	4	1	4	5	20
3	-	1	-	1	3	5
4	4	8	7	7	9	35
5	-	7	-	3	3	13
6a	1	5	3	6	2	17
6b	9	8	7	8	7	39
7	9	10	9	11	4	43
8a	3	5	6	2	4	20
8b	1	4	-	2	3	10
9a	1	6	2	4	4	17
9b	2	7	5	2	4	20
9c	4	6	2	1	4	17
9d	5	10	2	1	2	20
9e	1	8	2	3	5	19
9f	-	-	1	1	1	3
10	5	4	2	2	7	20
11	1	5	-	1	2	9
12	5	1	1	3	1	11
TOTALS	61	110	54	70	77	372
Number of Participants	20	17	11	16	11	75
Mean	3.05	5.29	4.91	4.38	7.00	4.96

TABLE 24B

EDUCATIONAL PLANS OF PARTICIPANTS

ITEM	ACTIVITY SELECTED	NUMBER
7	Establish professional relationships with a local or nearby chapter of the Fluid Power Society and participate in its activities.	43
6b	Prepare a course of study for a new unit or course.	39
4	Add one or more courses to make a curriculum in Fluid Power.	35
1	Introduce a unit of Fluid Power in an existing course.	34
2	Introduce a course in Fluid Power.	20
8a	Obtain assistance of local members of the Fluid Power Society as an unofficial advisory group.	20
9b	Involve the advisory group or committee in selecting laboratory devices, planning layout of the laboratory.	20
9d	Involve the advisory group or committee in selecting teaching aids.	20
10	Prepare an evening program for employed adults.	20
9e	Involve the advisory group or committee in placement of graduates.	19
6a	Prepare a course of study for an existing unit or course.	17
9a	Involve the advisory group or committee in constructing courses of study.	17
9c	Involve the advisory group or committee in selecting instructional materials.	17
5	Remodel facilities to provide a separate room, and equip it with laboratory and demonstration equipment.	13

TABLE 24B
Continued

EDUCATIONAL PLANS OF PARTICIPANTS

ITEM	ACTIVITY SELECTED	NUMBER
12	Other	11
8b	Obtain assistance of local members of the Fluid Power Society as an appointed advisory committee.	10
11	Work with an education committee to prepare curriculum guides for a city or state.	9
3	Add one or more courses to make a curriculum in Fluid Power.	5
9f	Involve the advisory group or committee in other activities.	3

port was prepared with the name of the participant, and with the activities checked that he had originally selected. Thus, the report required only that the participant indicate what he had accomplished by placing check marks in one of four columns: Accomplished, In Planning Stage, Scheduled for Next Year, and Dropped.

Since Progress Reports were not requested from guest participants from Canada and Nigeria, the number of participants from whom reports were requested was 67, and 47 or 70% responded. Of this number, one participant reported that he had resigned from his teaching assignment and had accepted a position with one of the manufacturers of fluid power components; another reported that he had been accepted in the Peace Corps. Two letters were returned for change in address.

From all other reports, information has been summarized in Table 25. It will be noted that of 180 planned activities, 99 or 55% were reported as accomplished, 44 or 24% were in the planning stage, 25 or 14% had been scheduled for next year, and another 25 or 14% had been dropped. The total activities reported--193, exceeded the number planned--180.

While such reports are revealing, comments added by participants assist in giving meaning to the data. Some of these are: "Budget of $40,000 for equipment approved"; "was a guest speaker at a meeting of the Fluid Power Society"; "Surprise! I have a new room just for Fluid Power"; "No progress. Was appointed supervisor and had to drop plans for now"; "Not one but three new courses are approved as a curriculum"; "Helping to organize a new chapter of the Fluid Power Society"; "I have been getting components and cut-aways from local manufacturers and have my lab equipped."

TABLE 25

EDUCATIONAL PLANS: PROGRESS

Activity	Planned	Accomplished	In Planning Stage	Scheduled For Next Year	Dropped
1	19	10	8	2	
2	14	6	6	2	4
3	2	1	1	2	
4	19	12	10	0	1
5	8	3	6	1	1
6a	10	8	3	0	1
6b	20	12	9	2	1
7	17	16	5	3	4
8a	6	3	2	3	2
8b	7	3	4	1	0
9a	6	2	3	1	2
9b	10	4	9	2	2
9c	9	6	7	2	0
9d	8	4	6	2	0
9e	7	2	7	1	0
9f					
10	11	5	4	1	4
11	2				
12	5	2	1	0	3
TOTALS	180	99	44	25	25
PERCENT		55.5	24.4	13.9	13.9
SUMMARY	180	193			

FINAL REPORT. Near the end of the school year, each participant was sent a form for reporting accomplishments in completing his educational plans. Enclosed was a covering letter, and a self-addressed and stamped envelope. The final report was prepared with the name of the participant indicated, and with the activities checked which he had originally selected. Thus, the report was easy to complete and to return.

Of the 68 participants, final reports were received from 65 or 95 percent. Information from these is summarized in Table 26.

It will be noted that of 294 as planned activities, 174 or 46.4 percent were reported as completed; 104 or 27.7 percent were still in the planning stage; 69 or 18.4 percent were scheduled for next year; and 28 or 7.4 percent had been dropped. The number of activities added to the original list was 81.

The question might be asked, "How do the percentage of responses of the 1966 institutes compare with those of 1965?" To make such a comparison, it would be necessary to exclude those participants in the 1966 institutes who were guests from other countries and those who, for one reason or another, were not teaching during the 1966-67 school year so that the two groups would be similar.

With this adjustment, percentages of final reports were calculated and the significance of the difference between these proportions calculated. As may be noted in Table 27, the response for the 1965 institutes was 80 percent while that for 1966 was 95 percent. Since the difference between the two proportions is 2.9 times the standard error of the difference, there is about one chance in 100 that the difference is a chance difference due to sampling and is not significant.

Using the same technique, the accomplishments of the participants of the two groups of institutes were also compared. Shown in Table 28 are the number and percentages of activities reported as accomplished, in the planning stage, scheduled for next year, and dropped. For each of the four pairs of responses, the standard error of the difference in proportions was calculated, and the significance of each reported in terms of probability.

It will be noted that the difference in percentages for activities planned, those accomplished during the year, those in the planning stage, and those scheduled for next year were significant at the 99 percent confidence level. The difference in percentages of planned activities which were dropped, however, was not statistically significant; it is assumed therefore that there was little difference, if any, between the 1965 and 1966 participants in the number of planned activities which they dropped.

From a review of the data obtained by follow-up studies, it will be noted that the accomplishments of participants in the 1966 institutes paralleled those in the 1965 institutes and it may be concluded, therefore, that the 1965 procedures selected for testing in 1966 were workable and productive in achieving the objective of introducing a new technology into schools.

TABLE 26

EDUCATIONAL PLANS: FINAL REPORT

Activity	Planned	Accomplished	In Planning Stage	Scheduled For Next Year	Dropped
1	32	19	6	6	2
2	25	17	2	4	4
3	6	4	4	2	0
4	32	17	11	6	2
5	8	8	4	4	0
6a	9	21	2	0	0
6b	39	28	8	8	0
7	33	21	9	6	2
8a	9	4	4	6	2
8b	8	4	4	2	0
9a	13	0	6	4	6
9b	8	4	4	2	0
9c	13	0	6	4	6
9d	17	13	11	2	0
9e	9	2	9	0	0
9f	2	0	0	0	2
10	17	6	6	11	0
11	6	0	4	2	0
12	8	6	4	0	2
Totals	294	174	104	69	28
Percent		46.4	27.7	18.4	7.4
Summary	294		375		

TABLE 27

COMPARISON OF RESPONSES FROM 1965 AND 1966 INSTITUTE PARTICIPANTS

Institutes	Participants	Reports Received	Per Cent Response
1965	167	134	.80
1966	68*	65	.95
Totals	235	199	.85

95% - 80% = 15%   S.E. = 5.13

$\frac{15}{5.13} = 2.9$ or $\frac{.373}{100}$ Probability

* Seven participants from Canada and Nigeria are not included in this summary.

TABLE 28

COMPARISONS OF ACCOMPLISHMENTS OF 1965 AND 1966 INSTITUTE PARTICIPANTS

Institutes	Accomplished No.	Accomplished Per Cent	In Planning Stage No.	In Planning Stage Per Cent	Scheduled For Next Year No.	Scheduled For Next Year Per Cent	Dropped No.	Dropped Per Cent
1965	303	46	230	35	68	10	55	8
1966	174	46.4	104	27.7	69	18.4	28	7.4
Difference		+.4		-7.3		+8.4		-.6

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

From an examination of the observations and data reported, it can be concluded that the multiple summer institute program is an effective device for introducing an emerging technology into education by serving four necessary functions: 1) identification and organization for teaching purposes the instructional content and materials of the new technology; 2) selection of appropriate and necessary laboratory experiences, and the design of laboratory facilities; 3) initial preparation of teachers and instructors; 4) provision for continuing contacts with the cooperating industry by teachers and instructors which is obviously necessary in an emerging technology.

It is not a device, however, for curriculum research leading to the publication of instructional materials and to the design and construction or evaluation of laboratory devices including training simulators. It is believed that these activities will follow the introduction of the new technology, and should be left to other agencies or to textbook writers and publishers, and school supply organizations.

The multi-institute program, in comparison with a series of single institutes having the same objective, provides the coordination of services and personnel needed to introduce a new technology, facilitates the cooperation of industry, and reduces administrative costs.

The planning and administration of such a program can be done effectively by the technical society representing the technology.

The Fluid Power Institutes, which were conceived as pilot programs and experimental in nature, provided instruction only in Basic Theory and Applications and hence appropriate for teachers at both the secondary and post-secondary levels. It should not be inferred, however, that a technology can be introduced by offering one basic program. Needed also are programs of specific training for jobs within the technology. For Fluid Power, these are installation of components; service and maintenance; and design, testing and trouble-shooting circuitry, and other jobs performed by the technician. For Fluid Power, at least two additional multi-institute programs are required.

Then too, it should be remembered that the multi-institute program is in-service in nature, and provides preparation only for those now teaching. Needed to provide a continuing supply of teachers is a program for teacher education. This could be accomplished by planning each multi-institute program as multi-level, establishing different criteria for selection of teacher educators, and require participation in each of the multi-institute programs to be offered. But in introducing new technologies, time is a factor which has high priority, and preparation of teachers takes from four to six years after programs are initiated and laboratories built.

To minimize delay in introducing programs in teacher education, a separate program is needed. This could be planned as a fellowship program extending over a period of one academic year and limited to faculty members from institutions offering both teacher education and technology programs. This stipulation is suggested because of administrative problems anticipated in justifying space and laboratory facilities, which for Fluid Power is estimated at $80,000 and which will have necessary but limited use during the school week unless the institution can also offer two or four year technology programs. It should be remembered that Fluid Power or any other technology is only one of a group of specializations within an Industrial Education or

Vocational Education major, and numbers in each are not large. For such a teacher education program, representation and committments should be no less than twenty-five institutions.

For both the multi-institute program and the teacher education fellowship program, three practices are believed to be central to their effectiveness and success. One, a committment by the school to introduce or improve an instructional program in the new technology, including the necessary laboratories, should be required as one criteria for participation. There is little justification for the expenditure of funds to develop program capabilities of teachers for schools which have little if any interest in introducing or developing the program in the first place.

Two, the amount of participant support and allowances for dependents and travel, made available for other institutes and fellowships must be provided for those planned to introduce a new technology. This was not done for the 1966 Fluid Power institutes because funds were not availavle due to a reduction in Congressional appropriations for Vocational Education, and participation was limited. In Industrial-Vocational Education, teachers are men most of whom have families to support and must work during the summer months. Without such income, and for institute programs lacking funds for support and allowances, they are effectively barred from participation.

Three, the follow-up study should be expanded and the results used to evaluate the effectiveness of multi-institutes and fellowships. Provisions for follow-up studies are not common and in some published guide lines follow-up studies are excluded. But if a multi-institute and fellowship program have as their aim to introduce a new technology, then the only valid measure of their effectiveness and success is the number of new programs introduced, those expanded, and the numbers of students thereby served. Those who object to follow-up studies raise doubts of the validity of the purpose of their institute programs by implying that there are no observable results or that the results are of little consequence. A follow-up study, in addition to its rather obvious purpose, also validates the announced objectives of the institute or fellowship program.

SUGGESTED PROCEDURES FOR PLANNING AND CONDUCTING MULTIPLE SUMMER INSTITUTES PROGRAMS

The procedures which proved to be successful in the first Fluid Power Institute in 1964 were selected and used again in the 1965 Institutes supplemented by others previously untried. From all of these, the most promising were selected for testing in the 1966 Institutes. In the preceding chapters, these various activities and approaches have been described, and the effectiveness of each, as contributing to the total success of the institutes, has been appraised. As a group, these selected procedures for introducing a new technology into schools by means of a multi-institute program constitute the conclusions and recommendations of this pilot study.

1. Select staff members as soon as possible, and assign responsibilitites. A minimum of three are needed; one for administration, and two for planning and coordination. Dividing these different responsibilities is advantageous because of the amount of detail in each.

2. Invite institutions known as having an interest, and those which may possibly be interested, to apply for an institute using a form

prepared for that purpose. Needed information includes previous institute experience of the director; technical and professional qualifications of the instructors; laboratory, lecture-demonstration, and group study facilities; living accomodations; potential field trips and other pertinent industrial resources; and, of course, budget.

Next, make a tentative selection of institutions using the information above as criteria; include geographical area to be served. For minimum coverage, experience has shown that a minimum of ten institutes are needed.

Before final selection is made, arrange for the coordinator to visit each institution to inspect facilities using a check list, and to meet with the tentative director and instructors.

3. Invite the cooperation of industry by mail or at scheduled meetings. Describe the program and its objectives, and indicate the nature of assistance or service needed such as: local advisory committees, guest-lecturers, field trips, possible customer training programs, instructional material and teaching aids.

   Through the appropriate technical societies, arrange guest memberships for participants and their identification with local or nearby chapters.

4. Plan the entire program as a unit so that institute programs, cooperation of industry, coordination, evaluation, final report and a follow-up study will be coordinated, and so that each person will know his own responsibilities and how these are inter-related to those of others.

5. In planning for institute programs, include instruction and laboratory experiences, professional seminar, and social-professional experiences. For planning, outline informational content and specify seminar topics and assignments; establish guide lines and minimum time allocations for each phase of the program. Recommend the use of an advisory committee. Include provisions for early staff review and approval of each institute program.

6. For participant selection, establish criteria, design and duplicate application forms, and select publicity media. If the institute program is basic and introductory, participants may be selected from various educational levels, high school to teacher education. But if the institute program is designed to prepare instructors for a particular group of work assignments, select participants from corresponding school programs. In either case, include those in teacher education so that a supply of needed instructors can be made available later as needed.

   Of major importance is the requirement that the participant is now teaching a unit or course in the new technology, or is expected to do so in the next school year. Information from follow-up studies suggests the obvious desirability of requiring also, an appropriate committment from the school administrator covering curriculum space or time, and budget for instructional materials and laboratory equipment.

   Direct applicants to mail their forms to the institution nearest to them. Give the institute director authority to screen and to select participants, and request periodic reports from him.

7. Conduct a planning meeting with institute directors. Provide copies of comprehensive plans and review everyone's responsibilities. Study guide lines for institute programs and set dates for submitting checking-copies of programs. Cover all details of program operation, discuss any potential problems and examine alternate solutions, answer questions and provide any help needed.

8. Provide services of the coordinator by telephone or personal visit according to the nature of the service required or the problem encountered. Arrange for at least one visit to each institution during the program by one of the three staff members.

9. At the end of the institutes, conduct a summary meeting with directors and staff. Schedule a report from each director on his institute, request and collect suggestions and recommendations.

10. As part of the planning for institute evaluations, include an initial and final test, and participant-kept daily records and evaluations. Summaries of data thus obtained are of value to the institute director in making an assessment of the quality of his own program, and in determining final grades of his participants. Specify that these summaries be included in the director's report.

11. In the final report, include institute objectives, guide lines for program content, time allocations, institutions selected and institute dates, names of directors and instructors, names and addresses of participants; assess the quality of the total institute program using summaries of examination scores and participant evaluations of instruction, laboratory work, seminar, and social-professional activities; assess the cooperation of industry

using summaries of numbers of consultants and guest-lecturers, numbers and kinds of instructional aids and materials contributed, and number of guest-memberships in technical societies.

12. Evaluate the program using data obtained from a follow-up study providing for participant plans, and later progress and final reports. Summarize numbers of new and revised instructional programs, numbers of students served, improved and new laboratory facilities, and resulting technical and professional activities of participants. Compare achievement with estimates of existing needs, and make appropriate recommendations.

FLUID POWER SOCIETY
P. O. Box 49 THIENSVILLE. WISCONSIN CH. 2-2010

October 28, 1965

ADDRESS REPLY TO:

IMPORTANT NOTICE . . . ACTION REQUESTED BY NOVEMBER 15

To: Colleges and Universities Which Have Expressed Interest in Holding a Summer Institute on Fluid Power Education in 1966

Re: Application for Support of Institutes

During the summer of 1965, the Office of Health, Education, and Welfare, under the provisions of the Vocational Education Act of 1963 granted some $234,000 to the Fluid Power Society in Support of Summer Institutes on Fluid Power Education. The Society subcontracted with five universities for seven institutes involving a total of 168 participants.

Participants were teachers of vocational and industrial education in high schools, vocational schools, and technical institutes. Purposes of the Institutes were to provide participants with a background on fluid power technology which would aid them in establishing and offering courses or units of existing courses involving fluid power. Please see the attached abstract of the 1965 program for further background.

Shortly after November 15, the Society will request funds from the Office of Education to support additional institutes in 1966. We have reason to believe that your institution would be interested in sponsoring an institute, and we invite you to submit an application. Please use the enclosed application forms. Fill them out, retain one for your files, and send the other to the Society Headquarters.

Please follow these basic assumptions:

> There should be between 175 and 210 hours of class and laboratory work.
>
> The Director should plan on three weeks full time prior to, and following, the actual dates of the Institute, for planning and follow-up.
>
> The major part of the instruction should be the responsibility of the instructor. Guest Lecturers may be used to supplement instruction.
>
> The college or university making application has adequate classroom and laboratory space for a fluid power program, and will invest in a substantial part of the necessary teaching demonstration devices and laboratory equipment.
>
> Number of Participants should be limited to 16 per full-time instructor.
>
> Institutes should be no less than 5 weeks and no more than 6 weeks in length.

Should the Office of Education give tentative approval to this project, we shall so notify you and work out the firm budget and contract with your institution. Meanwhile, we shall appreciate receiving your application. If you have any questions, please call me -- Area 414/242-2010 or 354-7050.

Theodore Pearce
Executive Vice President

TP:I
Enc.

APPLICATION FOR 1966 SUMMER INSTITUTES ON

FLUID POWER EDUCATION

College or University: ______________________________

Address: ______________________________
Street & No.

____
City State Zip Code

Submitted by: Name ____________________ Title ____________
Phone: Area ______ Number ____________ Ext. ________

Contract Officer: Name ____________________ Title ____________
Phone: Area ______ Number ____________ Ext. ________

Proposed Staff, Full Time

Director: Name ____________________ Title ____________

Instructor: Name ____________________ Title ____________
(Please attach a biographical report showing technical and professional competencies)

Secretary: Name ____________________

Facilities

Please describe present facilities for lecture, for laboratory work in fluid power, and for group study

Number of Participants Anticipated: ____________

Living Accommodations

Please describe dormitory facilities, campus parking, and food service, together with costs of each.

Social-Professional Activities

What field trips can be made to observe fluid power applications? Describe facilities and opportunities for social and recreational activities.

Is there a local chapter of the Fluid Power Society near the campus? If so, what chapter is it?

College Credit Graduate: __________hours. Undergraduate: ________hours

Tuition:		Out-of-State	Resident
	Graduate	$__________	$__________
	Undergraduate	__________	__________

Starting Date____________________Closing Date____________________

Tentative Budget:

Salaries, FICA, etc.	$__________
Telephone & Telegraph	__________
Office Supplies	__________
Field Trips (bus, etc.)	__________
Staff Travel	__________
Guest Lecturer Expense	__________
Miscellaneous	__________
Subtotal	$__________
Overhead (20% of Subtotal)	$__________
TOTAL EXPENSE	$__________

NOTE: Support of participants (stipend). Participant travel, educational materials and other expenses to be determined later, and should not be included in the tentative budget.

Remarks:

RETURN THIS FORM PRIOR TO NOVEMBER 15, 1965, TO THE FLUID POWER SOCIETY, P. O. BOX 49
THIENSVILLE, WISCONSIN 53092
PHONE AREA 414/242-2010

1966 FLUID POWER INSTITUTES

PROGRAM PLANNING, COORDINATION, AND EVALUATION

- o O o -

April 15, 1966

THE FLUID POWER SOCIETY

Thiensville, Wisconsin

PREFACE

This report is a comprehensive plan for the 1966 Summer Institute. As such, it will be useful to Institute Directors in planning programs, to the Institute Coordinator in assisting the Directors to make maximum use of resources and previous experience, and to the Evaluation Committee in reviewing the data collected and summarized.

Comprehensive planning of this sort is new to the Fluid Power Institute Program. Circumstances leading to funding of the 1965 Institutes were such as to leave little time for planning. But this year with both time and previous experience, we have been able to do the planning necessary and thereby coordinate the efforts of all who will be engaged in the total program.

This year we were hopeful that the Institute Program could be expanded, but the number of Institutes had to be reduced to five because of budget limitations and previous commitments for other institute programs. This may be an advantage, however, for working with a smaller number of programs should enable us to do a better job, and to test more thoroughly some of the techniques believed to be useful in introducing any new technology into school programs.

Of the five institutions which will offer Summer Institutes in 1966, two have not had sponsored institutes in Fluid Power before. But the staff of these have all participated in Summer Institutes, and are knowledgeable and enthusiastic.

Thorough planning and highly-competent staff should result in programs which are highly successful. In your work, the Fluid Power Society will always be ready to assist you in any way.

Theodore Pearce
Executive Vice President
The Fluid Power Society

Frederick Lamb
Institute Coordinator

Gerald B. Baysinger
Director of Evaluation

CONTENT

Page

List of Tables 1

Data-Collecting and Other Instruments 2

Institutions, Staff, and Dates for 1966 Fluid Power Institutes 3

Introduction 4

I Physical Facilities 5

II Program 15

III Participants 18

IV Qualifications of Instructors 21

V Quality of Institute Programs 27

Instructional Content 27

Lecture-Demonstrations 29

Laboratory Experiences 33

Professional Seminar 37

Social-Professional Activities 40

VI Cooperation of Industry 44

VII Follow-Up Study of Participants 51

VIII Recommended Preparation and Qualifications of Instructors of Fluid Power 63

IX Suggested Procedures for Introducing a New Technology into Education 63

X Suggested Outline: Final Report 64

LIST OF TABLES

TABLE Page

1. Adequacy of Physical Facilities: Institute I 5
2. Adequacy of Physical Facilities: Institute II 6
3. Adequacy of Physical Facilities: Institute III 6
4. Adequacy of Physical Facilities: Institute IV 7
5. Adequacy of Physical Facilities: Institute V 7
6. Adequacy of Physical Facilities: Summary 8
7. Participants, Schools, School Addresses 20
8. Participants: Type of Program or School Level 20
9. Participants: Geographical Area 20
10. Evaluation of Technical-Professional Competencies of Instructors. 27
11. Differences Between Mean Scores of Initial and Final Examinations 28
12. Participant Appraisals of Lecture Demonstrations 32
13. Participant Participation and Appraisals of Laboratory Experiences 36
14. Number and Percent of Seminar Assignments Completed 39
15. Percent of Participation in Social-Professional Activities 43
16. Summer Institute Committees: Numbers Involved 49
17. Summer Institute Committees: Time Spent 49
18. Instructional Materials and Teaching Aids 50
19. Educational Plans of Participants 55
20. Educational Plans: Progress 60
21. Educational Plans: Final Report 62

DATA-COLLECTING AND OTHER INSTRUMENTS

FORM NUMBER — Page

1-66 Physical Facilities Check List 9

2-66 Participant Eligibility Certification 18

Director's Report

3-66 I Participants 19

4-66 II Participants: Type of Program 19

5-66 III Participants By States 19

6-66 Personal Information: Instructor 23

7-66 Evaluation of Technical-Professional Competencies of Instructors 22

8-66 Daily Log: Lecture-Demonstrations 30

9-66 Tally Sheet: Lecture-Demonstrations 32

10-66 Daily Log: Laboratory Experiences 34

11-66 Tally Sheet: Laboratory Experiences 35

12-66 Daily Log: Professional Seminar 38

13-66 Daily Log: Social-Professional Activities 41

14-66 Tally Sheet: Social-Professional Activities 42

Director's Report

15-66 IV Summer Institute Committee 45

16-66 V Guest Lecturers 46

17-66 VI Instructional Materials and Teaching Aids 48

18-66 Educational Plans for Next Year 53

19-66 Progress Report 58

INSTITUTIONS, STAFF, AND DATES FOR 1966 FLUID POWER INSTITUTES

Bradley University: Peoria, Illinois

Director:	Billy D. Hayes
Instructor:	Dean Long

June 13 to July 15, 1966

California State College: Los Angeles, California

Director:	Ray Fausel
Instructor:	Les Aldrich

August 1 to September 2, 1966

Hampton Institute: Hampton, Virginia

Director:	John L. Frank
Instructor:	Morton Hopkins

June 30 to July 23, 1966

Trenton State College: Trenton, New Jersey

Director:	Vincent Dresser
Instructor:	Frank L. Mackin

June 27 to July 29, 1966

Wayne State University: Detroit, Michigan

Director:	Gerald Baysinger
Instructors:	William F. Gayde William D. Wolansky

June 27 to August 3, 1966

INTRODUCTION

This report was prepared for the use of the Institute Coordinator and Directors, and for members of the Evaluation Committee. Content is an extension of the brief descriptions of program, coordination, and evaluation approved in the contract with the Office of Education, and includes guidelines for all planning, coordination, and evaluation except those concerned with administration and budget.

In this form, the report also serves as a communication device: the Evaluation Committee will be informed of the details of the various Institute Programs, and the Directors will know of the responsibilities of the Evaluation Committee. It is expected that the work of both will thereby be more meaningful.

It should be kept in mind that the Fluid Power Institute is a pilot-experimental program rather than a research project. This requires that we devise and try-out, and keep records of how our plans worked in practice. We do not have funds and a larger number of institutes which would permit testing various techniques both individually and in combination with others. As a result, we must supplement data we obtain with judgment based upon experience.

Important in achieving the objectives of the pilot-experimental program are thorough planning of what is to be done and accurate reporting of what was done. This report is intended as an aid in these endeavors, and details should not be considered as final but always subject to change and improvement.

I

PHYSICAL FACILITIES

Important to the success of an Institute on Fluid Power are the nature and quality of living accommodations and food service provided for participants; and adequate classroom, laboratory, and group-study facilities including provisions for typing and duplicating. These physical facilities will vary from institution to institution, of course; and conceivably some institutions may not have all of the needed facilities available, but could make other arrangements or make satisfactory adjustments if they were informed early of what was needed. Then too, previous experience gained from the 1965 Summer Institutes should be helpful in assisting institutions which will conduct Institutes.

Accordingly, five checklists have been developed for the use of the Institute Coordinator. It is intended that he will visit each of the institutions as soon as such trips can be scheduled and, with the Institute Director, visit and inspect the physical facilities recording his observations on the checklists. Any problems which he might identify, he will discuss with the Director, explore possible solutions and select one or more which may be workable. Previous to the opening of the Institute, he will check progress with the Director. For minor problems, he might do this by telephone or correspondence, but a major problem may require him to make a second visit to the Institution.

As a result of this activity, adequacy of physical facilities at each of the Institutions will be maximized.

The adequacy of physical facilities will be made a part of the evaluation; this will be reported by institution and summarized for all institutions.

Table 1

ADEQUACY OF PHYSICAL FACILITIES: INSTITUTE I

Facility	Evaluation				
	1	2	3	4	5
1. Living Accommodations					
2. Food Service					
3. Lecture-Demonstration					
4. Laboratory					
5. Group Study					
Overall Evaluation					

Code: 1 - Excellent
2 - Good
3 - Adequate
4 - Acceptable
5 - Some Problems

Table 2

ADEQUACY OF PHYSICAL FACILITIES: INSTITUTE II

Facility	Evaluation				
	1	2	3	4	5
1. Living Accommodations					
2. Food Service					
3. Lecture-Demonstration					
4. Laboratory					
5. Group Study					
Overall Evaluation					

Table 3

ADEQUACY OF PHYSICAL FACILITIES: INSTITUTE III

Facility	Evaluation				
	1	2	3	4	5
1. Living Accommodations					
2. Food Service					
3. Lecture-Demonstration					
4. Laboratory					
5. Group Study					
Overall Evaluation					

Code: 1 - Excellent
2 - Good
3 - Adequate
4 - Acceptable
5 - Some Problems

Table 4

ADEQUACY OF PHYSICAL FACILITIES: INSTITUTE IV

Facility	Evaluation				
	1	2	3	4	5
1. Living Accommodations					
2. Food Service					
3. Lecture-Demonstration					
4. Laboratory					
5. Group Study					
Overall Evaluation					

Table 5

ADEQUACY OF PHYSICAL FACILITIES: INSTITUTE V

Facility	Evaluation				
	1	2	3	4	5
1. Living Accommodations					
2. Food Service					
3. Lecture-Demonstration					
4. Laboratory					
5. Group Study					
Overall Evaluation					

Table 6

ADEQUACY OF PHYSICAL FACILITIES: SUMMARY

Facility	Frequency				
	1	2	3	4	5
1. Living Accommodations					
2. Food Service					
3. Lecture-Demonstration					
4. Laboratory					
5. Group Study					
Overall Frequency					

Code:
1 - Excellent
2 - Good
3 - Adequate
4 - Acceptable
5 - Some Problems

In addition, the evaluation will include a report by the Institute Coordinator on each of the problems encountered and resolved.

1966 FLUID POWER INSTITUTES

PHYSICAL FACILITIES CHECKLIST

- o O o -

INSTITUTION: ____________________

DATE: ____________________

PRELIMINARY ☐ FINAL ☐

OBSERVER: ____________________

Form 1-66

1. Living Accommodations

Item	Yes	No
1. Maid Service		
2. Clothes Storage		
3. Toilet a. Private		
b. Group		
4. Bath a. Private		
b. Group		
5. Telephone a. Room		
b. Corridor		
c. Building		
6. Mail-Message Service		
7. Study Facilities		
8. Television		
9. Radio		
10. Air Conditioning		
11. Distance to Classroom a. Walking distance		
b. Transportation needed		
12. Parking a. Free		
b. Charge		
c. None available		

General Evaluation:

1. Excellent ☐
2. Good ☐
3. Adequate ☐
4. Acceptable ☐
5. Some Problems ☐

Recommendations:

2. Food Service

Item	Yes	No
1. Meals Provided		
a. Breakfast		
b. Lunch		
c. Dinner		
2. Service Available		
a. Weekdays only		
b. Seven-days		
3. Menu Choice		
a. Daily Specials only		
b. A la carte		
4. Air Conditioning		
5. Distance from Dormitory		
a. Walking distance		
b. Transportation needed		
6. Distance from Classroom		
a. Walking distance		
b. Transportation needed		

General Evaluation:

1. Excellent ☐
2. Good ☐
3. Adequate ☐
4. Acceptable ☐
5. Some Problems ☐

Recommendations:

3. Lecture-Demonstration Facilities

Item	Yes	No
1. Seating-Work Space a. Tablet-Arm chairs		
b. Chairs and tables		
2. Chalkboard		
3. Projected-Picture Facilities a. Projection screen		
b. Overhead projector		
c. Slide-Film strip projector		
d. Motion picture projector		
4. Adequate Space for Demonstration Equipment		
5. Room Library a. Shelving for manuals, text and reference books		
b. Check-out provisions		
6. Air Conditioning		
7. Coffee Breaks a. Vending machine		
b. Coffee urn; coffee service		

General Evaluation:
1. Excellent ☐
2. Good ☐
3. Adequate ☐
4. Acceptable ☐
5. Some Problems ☐

Recommendations:

4. Laboratory Facilities

Item	Yes	No
1. Assembly-Disassembly of Components		
a. Bench space		
b. Storage of components and cut-aways		
c. Hand tools		
(1) Types needed		
(2) Adequarte number of each		
(3) Tool panel or racks for storage		
2. Tests and Experiments with Components and Circuits		
a. Equipment		
(1) Capital		
(2) Electromatic		
(3) Technical Equipment		
(4) Vega		
(5) Custom-built		
(6)		
(7)		
b. Hand tools		
(1) Types needed		
(2) Adequate number of each		
(3) Tool panel or racks for storage		
c. Safety equipment		
(1) Face shields or goggles		
(2) Oily waste cans		
(3) Aprons or coats		
d. Supplies		
(1) Oil		
(2) Wiping cloths		
3. Air Conditioning		

General Evaluation:

1. Excellent ☐
2. Good ☐
3. Adequate ☐
4. Acceptable ☐
5. Some Problems ☐

Comments:

5. Group Study Facilities

Item	Yes	No
1. Location of Facilities		
a. Dormitory		
b. Classroom		
c. Library		
d. Other		
2. Availability		
a. Evenings		
b. Weekends		
3. Typing and Duplicating		
a. Services are provided without charge		
b. Equipment provided for participant use		
c. Equipment available for participant use		

General Evaluation:

1. Excellent ☐
2. Good ☐
3. Adequate ☐
4. Acceptable ☐
5. Some Problems ☐

Comments:

II

PROGRAM

As developed over the past two summers, the Institute Program is conceived as consisting of three groups of activities: an instructional program, professional seminar, and social-professional activities. To obtain best results, the three groups of activities should be conceived as a whole, each should be thoroughly planned in advance, and copies should be given to participants. But the same program will not be suitable for each institution: laboratory experiments will vary according to the available equipment, availability of guest-lecturers will vary, and the kind and number of field trips can only be planned on a local basis. Thus, each institution will be asked to plan its own program.

At the Spring meeting of Directors, guidelines will be presented and discussed, and each Director will be asked to submit a working copy of his program.

The Institute Coordinator will review the program submitted, make suggestions based upon his experiences the previous summer, and return it to the Director who, in turn, will make the suggested changes and duplicate the necessary copies. Timing, of course, will be critical. Accordingly, a time schedule for program development will be established with the Directors at the Spring meeting:

Working copy due ____________________

Working copy returned ________________

Final copy due ______________________

GUIDELINES

Content: Instructional Program

Fluid Power includes both Hydraulics and Pneumatics; the instructional topics, therefore, will include both.

Each program should cover the following topics:

Hydraulics	Pneumatics
Basic Laws	Basic Laws
Language: Symbols, Terms	Language: Symbols, Terms
Fluids	Conditioners
Fluid Conditioners	F. R. L.
Pumps	Valves
Pressure-Control Valves	Actuators
Flow-Control Valves	Conductors
Actuators and Motors	Circuits
Boosters and Accumulators	
Conductors	
Circuits	

Content: Professional Seminar

It is intended that the Institute Program will be of maximum assistance to the participant when he returns to his teaching assignment. He will acquire the skills and knowledge by participating in the instructional program; plans for improvement or introduction of Fluid Power he will make with the assistance of others in the Seminar.

SUGGESTED ACTIVITIES

1. Group participants by school level: high school, vocational, community college and technical institute, four years college, teacher education.
2. Meet with all groups two evenings each week: arrange for groups to meet individually, two other evenings per week.
3. With each group:
    a. Develop an outline for a course in Fluid Power
    b. Review and select texts
    c. Review and select films
    d. Review and select laboratory equipment, tools, supplies, safety equipment
    e. Develop a laboratory layout for:
        (1) an existing shop or room, or
        (2) a new room
    f. Assemble and pack catalogs, manuals, etc.
4. For each group, require bound copies of a report: two for each member, and one for the Institute:
    a. Course outline
    b. Text, films, equipment lists: vendors, costs
    c. Laboratory layout (individual)

Time Allocation

The number of contact hours should total 190 clock hours, and be distributed as shown in the following schedule:

Lecture-Demonstration
    Hydraulics ------------- 60
    Pneumatics ------------- 40
Laboratory Work ---------------- 50
Field Trips--------------------- 16
Seminar ------------------------- 24
Social-Professional --------------- Open

Allocations shown should be considered minimal; the Director may add hours if he wishes to do so. In any case, the working copy submitted by the Director should include a time allocation report.

Format

For review purposes, and because there is merit in using the same format for programs since copies will be included in the final report, Directors will be asked to following the guidelines suggested.

(Cover Page)

(Name of Institution)
FLUID POWER INSTITUTE

(Beginning Date - Closing Date)

Director: ____________________

Instructor: ____________________

For the daily program of activities and events, show the date, and starting and closing time for each activity.

For a lecture-demonstration, list the instructional topic, and the text or reference study assignment.

For a guest-lecturer, list the topic, show his name, position, and company, and list the study assignment.

For laboratory work, indicate the names of one or more activities and/or experiments that participants will be assigned to do.

For seminar, list topics for discussion, and show assignments.

For field trips, give name of company to be visited, address, and leaving time.

For social-professional activities, list the activity, and give location, cost if any, and other necessary details.

EVALUATION

Program planning is one of the activities which determine the quality of the Institute Program. Of concern are content of the instructional program and time allocation for various activities. The procedures described will assure that, for each Institute, the program will be planned in advance, that it will make provisions for a specified instructional program and for such field trips and social-professional activities as may be desirable and available, and that a time allocation for each has been made to assure a balanced program.

The final report, then, will include a description of the program-planning procedure, and a copy of each program including time allocations.

III

PARTICIPANTS

Eligibility

Fluid Power Institutes are intended for those who are now teaching, or who will be teaching during the coming school year, a program in Fluid Power. To be accepted as a participant, therefore, the applicant is required to present the necessary credentials which may be in the form of a statement or letter signed by his superior. Application is made to the Institution, and the Director of the Fluid Power Institute is empowered to accept or reject the application.

For those whom he accepts, he should have supporting evidence of their eligibility. This will be affirmed by the Institute Coordinator who, upon visiting the Institution, will inspect the records of each participant and make a written report to the Contractor - The Fluid Power Society.

(Participant Eligibility Certification)

Mr. Theodore Pearce
The Fluid Power Society
P. O. Box 49
Thiensville, Wisconsin 53092

Dear Mr. Pearce:

On (date) I visited (Institution), and inspected the credentials of the participants. Of the (number) accepted in the program, (number) meet requirements established for eligibility.

Sincerely yours,

Institute Coordinator

Form 2-66

Reports

During the first week of the Institute, the Director is requested to report the following information:

1. Name of participants
2. Name of schools, school addresses
3. Type of school

Reporting will be done using a standard format to assure uniformity.

REPORT I

Institution: ____________________ Director: ____________________

PARTICIPANTS

Form 3-66

Name of Participant	School	School Address

REPORT II

Institution: ____________________ Director: ____________________

PARTICIPANTS: TYPE OF PROGRAM

Form 4-66

Type of Program	Number of Participants
High School	
Vocational School	
Community-Junior College	
Technical Institute	
Four-Year Technology	
Teacher Education	
Other:	

REPORT III

Institution: ____________________ Director: ____________________

PARTICIPANTS BY STATES

Form 5-66

State	Number of Participants

In the final report, participant data will be summarized in three tables:

Table 7

PARTICIPANTS, SCHOOLS AND SCHOOL ADDRESSES

Institute	Name of Participant	School	School Address

Table 8

PARTICIPANTS: TYPE OF PROGRAM OR SCHOOL LEVEL

Program	Number of Participants
High School	
Vocational School	
Community-Junior College	
Technical Institute	
Four-Year Technology	
Teacher Education	

Table 9

PARTICIPANTS: GEOGRAPHICAL AREA

State	Number of Participants

QUALIFICATIONS OF INSTRUCTORS

Each Institute will be staffed by a Director and one or more instructors. While the Director is responsible for the total program, the instructors have the particular responsibility for lecture-demonstrations, laboratory work and seminar meetings. Accordingly, the extent of their technical and professional competencies is within the concern of program evaluation.

Of course, the Director or each Institute will have obtained the services of his instructors previous to an evaluation, and will have employed the best obtainable. All of this has been reported earlier to the Fluid Power Society which, in turn, has approved the selection informally by contracting with the Institution for a summer institute. Yet, evaluation of the program should include an evaluation of the instructional staff.

It is suggested, therefore, that the instruments and procedures used for the 1965 Summer Institutes be repeated.

Accordingly, the Institute Directors will be given copies of the form, "Personal Information: Instructor," and asked to have them completed and returned prior to the opening date of the Institute. These will be assembled by the Institute Coordinator, and presented to the Evaluation Committee who, in turn, will study the information, and make a judgment of competency using the form prepared for that purpose: "Evaluation of Technical-Professional Competencies."

In the final report, identities of instructors thus evaluated will not be indicated. The forms and procedures will be described, however, and the evaluations will be summarized.

EVALUATION OF TECHNICAL-PROFESSIONAL COMPETENCIES OF INSTRUCTORS

Name ____________________

Form 7-66

Item	Adequate	Acceptable	Doubtful
Formal Education			
Informal Education			
Teaching Experience			
Industrial Experience			
Professional-Technical Activities			

Evaluation:

☐ 1. Excellent
☐ 2. Good
☐ 3. Adequate
☐ 4. Acceptable
☐ 5. Inadequate for the assignment

Sub-Committee: ____________________

____

____

Date: ____________________

Form 6-66

FLUID POWER SOCIETY

PERSONAL INFORMATION: INSTRUCTOR

Name ______________________ ______________________
Last First

Position or Title ______________________

Institution ______________________

Address ______________________
Street and Number

______________ ______________ ______
City State Code

A. FORMAL EDUCATION

1.

Institution	Degree	Date

2. Technical Courses in Fluid Power

Course	Hours

3. Related Technical Courses

Course	Hours

4. Related Science and Mathematics

Course	Hours

5. Plant Training Programs and Internships

Company	Weeks	Year

B. **INFORMAL PROGRAMS**: (Please list any conferences or meetings on Fluid Power which you have attended, books which you have read and studied, and other informal educational experiences in Fluid Power.)

C. TEACHING EXPERIENCE

Institution or School	Subjects Taught	Grade Level	Year

D. INDUSTRIAL EXPERIENCE[1]

Job	Company	Dates

[1] Indicate any work assignment which included operation, service, maintenance, installation, or design of fluid power systems or components by circling the name of the job.

E. PROFESSIONAL-TECHNICAL ACTIVITIES: (Please List)

1. Participation in Fluid Power Society chapter Programs:

2. Preparation of instructional material in Fluid Power:

3. Preparation of magazine articles:

4. Participation in state and national meetings:

Table 10

EVALUATION OF TECHNICAL-PROFESSIONAL COMPETENCIES OF INSTRUCTORS: SUMMARY

Instructor	Evaluation				
	1	2	3	4	5
A					
B					
C					
D					
E					

Code:
1. Excellent
2. Good
3. Adequate
4. Acceptable
5. Inadequate for the Assignment

V

QUALITY OF INSTITUTE PROGRAMS

Instructional Content

The purpose of the instructional program is to acquaint the participant with the knowledge and information which he will need to teach a basic course in Fluid Power. What the participant has learned at the end of the Institute is a measure of the quality of the instructional program and reflects the quality and thoroughness of planning and preparation, and the technical and professional competencies and performance of the instructor and guest-lecturers. What the participant has learned, of course, can be determined by an examination. But since participants will have some knowledge previous to participation in the Institute, both an initial and final examination will be needed.

The test items in the examination used in the 1965 Institutes have been studied and 57 were found to discriminate positively. These will be divided into two equal groups thus forming a core of tested questions for the initial and the final examinations. The Institute Coordinator will then construct additional items so that the two tests will sample information in each of the instructional topics as listed under content: Instructional Program, Page 15.

Examinations will then be used experimentally with students at Wayne State University and Flint Junior Community College. For both forms of the examination, an item analysis will be made using differences in percentages. Items which do not discriminate positively will be discarded.

Revised examinations will then be duplicated. Copies of the initial examination will be mailed to each Director with directions for giving the examination which must be scheduled, of course, before any instruction is given. Copies of the final examinations will be mailed to each Director later to arrive during the last few days of the Institute so as to eliminate the possibility of inadvertently teaching to the examination.

Examinations will be corrected by staff personnel working under the direction of the Institute Coordinator.

Next, the means of the initial and final examinations for each Institute will be compared and any difference will be tested for significance using the F ratio at the .95 level. Finally, the data for all Institutes will be summarized in a table in which the Institutes are listed in rank order according to the amount of the difference between the initial and final examination scores.

In addition, the means of initial and final rescored examinations for all Institute participants will be calculated and compared as before.

Table 11

DIFFERENCES BETWEEN MEAN SCORES OF
INITIAL AND FINAL EXAMINATIONS

Institute	Rank	Mean Scores		Difference
		Final	Initial	
	1			
	2			
	3			
	4			
	5			
TOTAL				

Lecture-Demonstrations

Participants are all teachers, of course and, as teachers, they have two concerns at lecture-demonstrations: one, to acquire the information presented and to develop the understandings needed; and two, to appraise the effectiveness of the presentation for guidance in their own teaching. What they have or have not learned will be revealed by the final examination but, as an aid in appraising lecture-demonstrations, a daily log will be provided.

Copies will be provided each participant who will keep them in his notebook. For each lecture-demonstration, the participant will enter the date and the name of the topic; check the teaching aids used, if any; indicate whether the lesson had been presented by the instructor or guest lecturer; and finally, indicate the extent of his understanding of the information presented. From time to time, the instructor will remind participants to make their Daily Log entries. These will be of particular value to participants as they work on their Seminar assignments. Aware of the dual purpose of lecture-demonstrations, the instructor will, as teacher-educators say, professionalize the instruction.

The Daily Log has yet another value in that it can be used to reveal participant opinion regarding the quality of instruction. Accordingly, the Director will be asked to collect all Daily Logs, and mail them to the Institute Coordinator.

Using the Tally Sheet, office staff will record the participant's appraisal of his own understanding for each of the lecture-demonstrations, and indicate whether the lesson was presented by the instructor or a guest-lecturer.

For all participants, various appraisals will be totaled, and then multiplied by a scale value. The sums of all the totals divided by the sums of the products will represent an appraisal of all the lecture-demonstrations for each of the various Institutes.

These will be summarized in Table 12 which will show participants' appraisal for each Institute, and for all Institutes.

DAILY LOG
LECTURE-DEMONSTRATIONS

School ______________________ Name ______________________

Form 8-66

Date	Topic	Teaching Aids			Lecturer		Understanding		
		Visual	Cut-Aways	Equip.	Instr.	Guest	Thoro.	Some Quest.	Not Clear

TALLY SHEET: LECTURE-DEMONSTRATIONS

Institute ______________________

Form 9-66

Participant	Instructor			Guest-Lecturers		
	Thorough	Some Questions	Not Clear	Thorough	Some Questions	Not Clear
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
TOTALS						
SCALE VALUE	1	2	3	1	2	3
PRODUCT						
SUM OF TOTALS						
SUM OF PRODUCTS						
PRODUCTS/TOTALS						

Table 12

PARTICIPANT APPRAISALS OF LECTURE-DEMONSTRATIONS

Institute	Sum of Totals	Sum of Products	Mean Appraisal
I			
II			
III			
IV			
V			
TOTAL - ALL INSTITUTES			

Laboratory Experiences

For many teachers in Industrial Education, a subject or course has traditionally consisted of manipulative work and related instruction in a ratio of about 3 to 1. This additional time has been required so that students could develop the many manipulative skills. But in new technologies, the ratio is reversed; there are only a few manipulative skills to be developed and emphasis is required on the informational content.

The purposes of laboratory work in Fluid Power are to actualize concepts and reinforce understanding by providing first-hand experiences with components and circuitry. To assist participants in forming new concepts of laboratory work and for organizing and teaching new courses in this technology, they will be asked to appraise the educational value of each laboratory experience provided.

It is expected that such appraisals will be of great value to each participant as he works on his Seminar assignments.

A record for this purpose has been devised, and follows the form of the Daily Log for lecture-demonstrations. Copies will be provided each participant who will keep them in his notebook.

The Daily Log for laboratory experiences provides for recording the date, name of the activity on experiment, laboratory equipment used, time spent, an appraisal of the educational value of the experience, and the instructor's initials indicating that the activity or experiment was successfully completed. In this form, the Daily Log will serve three purposes: one, assist the participant in completing his Seminar assignments; two, serve as a record of completed laboratory work, and thus, useful to the instructor in determining final grades for participants; and three, as an evaluation of the Institute Program.

Accordingly, the Director will be asked to collect the Daily Log for each of the participants at the end of the program, and to send these to the Institute Coordinator. Under his direction, office staff will tally appraisals, number of experiences completed, and hours spent. With this done, they will calculate the average appraisal for the Institute, the average number of experiences completed per participant, and the average number of hours spent per participant.

These data will then be entered in Table 13, and averages calculated for the total Institute Program.

DAILY LOG
LABORATORY EXPERIENCES

School ____________________ Name ____________________

Form 10-66

Date	Activity or Experiment	Simulator Used	Time in Hours	Educational Value			Instructor Approval
				High	Some	Little	

TALLY SHEET: LABORATORY EXPERIENCES

Institute ______________________________

Form 11-66

Participant	Educational Value			Number of Experiences	Hours
	High	Some	Little		
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
TOTALS					
NUMBER OF PARTICIPANTS					
MEAN					
SCALE VALUE	1	2	3		
PRODUCT					
SUM OF PRODUCTS					
SUM OF TOTALS					
MEAN					

Table 13

PARTICIPANT PARTICIPATION AND APPRAISALS OF LABORATORY EXPERIENCES

Institute	Education Value			Number of Participants	Number of Experiences	Mean	Number of Hours	Mean
	Products	Totals	Means					
TOTAL -- All Institutes								

Professional Seminar

Experience indicates that group study, informal discussions, and joint-planning for introduction or improvement of Fluid Power in schools contributes to the success of the Institute: participant morale is higher, attitude is anticipatory and enthusiastic, frendships develop, and the assignments are completed with quality at a high level. Important are planning for regularly scheduled meetings, and provisions for group study.

The quality of the Seminar program is obviously difficult to assess; probably, the satisfactory completion of the suggested assignments is a valid criterion for this will require considerable interest in Fluid Power education, a willingness to devote much time and effort to do the necessary planning, and a sharing with others of ideas and responsibilities. Thus, if assignments were well-done and complete, it could be assumed that Seminar experiences were of high quality. On the other hand, if assignments were done in a careless fashion or if not all participants completed the assignments, then the quality of the Seminar could be described as low.

To obtain the information needed for evaluation purposes, a Daily Log has been designed. Copies will be made available to each Director, and these may be kept by the participant in his notebook. The Daily Log has been designed so that it will be useful also to the instructor for determining final grades.

At the end of the Institute, the Director will collect the Daily Log from each participant, and send them to the Institute Coordinator. Office staff will total and tabulate the data to show number and percentage of assignments completed and approved for each Institute and for all Institutes.

DAILY LOG
PROFESSIONAL SEMINAR

School ______________________

Name ______________________

Form 12-66

Date	Topic-Activity

	Assignment	Instructor Approval	Grade
1	Course Outline		
2	Texts, References		
3	Audio-Visuals		
4	Laboratory: Tools, Equipment, Supplies		
5	Shop Layout		
6			
7			
8			

Table 14

NUMBER AND PERCENT OF SEMINAR ASSIGNMENTS COMPLETED

Total Assignments Completed	Institute					All Institutes
	I	II	III	IV	V	
1						
2						
3						
4						
5						
Total Participants						
Percentage						

Social-Professional Activities

At each Institution, the majority of participants will be visiting the area for the first time and will enjoy historical sites and other nearby attractions which could be visited on week ends. These plus field trips, campus activities, and a final luncheon or dinner will all have been planned in advance and included in the program.

Like the Seminar, social-professional activities can build morale, stimulate high interest, and engender friendships. Thus, participation which is voluntary can be used as one of the measures of program quality.

To obtain information for evaluation purposes, copies of a Daily Log will be provided each participant who may keep them in his notebook. In the Log, the participant will list the date and the activity, and briefly record his impressions of degree of interest, thoroughness of arrangements, and the educational values of the activity.

Since the participant will probably not take his notebook with him when he participates in these activites, the instructor will need to remind participants to make their Log entries at the next meeting of the group.

At the end of the program, the Director will collect the Daily Log of each participant, and send these to the Institute Coordinator. The office staff will tally these on the sheet provided for that purpose, and calculate the percentage of participation. These data will then be summarized in Table 15 to show the percent of participation for each Institute and for all Institutes.

DAILY LOG
SOCIAL-PROFESSIONAL ACTIVITIES

School ____________________ Name ____________________

Form 13-66

Date	Activity	Impressions (Interest - Arrangements - Value)

TALLY SHEET
SOCIAL-PROFESSIONAL ACTIVITIES

Institute ______________________________

Form 14-66

Activities Scheduled	Number Participating	Col. 1 x Col. 2
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
TOTAL		
Activities Scheduled x Number of Participants		
Percentage of Participation		

Table 15

PERCENT OF PARTICIPATION IN SOCIAL-PROFESSIONAL ACTIVITIES

Institute	Activities Scheduled	Percent of Participation
I		
II		
III		
IV		
V		
TOTAL		

VI

COOPERATION OF INDUSTRY

For the purposes of evaluating and reporting, Industry is defined as consisting of member companies of the National Fluid Power Association, and chapters and members of the Fluid Power Society. Cooperation of Industry will be sought for the following services and materials:

1. Summer Institute Committees

    a. Serve as consultant to Institute staff in selection of teaching aids, laboratory supplies, hand tools; and in the planning and layout of the laboratory.

    b. Suggest field trips and assist in making arrangements if requested.

    c. Serve as guest lecturers on selected instructional topics.

2. Instructional Materials and Teaching Aids

    The Education Committee of the Fluid Power Society will write to member companies of the National Fluid Power Association suggesting that cutaway models, manuals, catalogs, and other available teaching aids be shipped to the Institutions. For each of these, name of Director, name of Institution, address, and number of participants will be included in the letters.

3. Memberships in The Fluid Power Society

    Each participant will be given a guest membership in the Fluid Power Society which will identify him with a local chapter of that organization, and he will receive monthly a copy of Hydraulics and Pneumatics, the Industry's technical and professional publication.

    In addition, he will be assisted by the Fluid Power Society in obtaining an internship with a component manufacturer or an enrollment in one of several customer-training schools. If the participant is interested in obtaining such additional training, either in the Summer of 1966 or later when the need for supplementary training becomes more evident, he will need only to write to the Fluid Power Society. Since this service to members who are teachers and instructors is a part of the Society's program, and since the need for additional training may not develop until the participant himself has introduced or expanded his Fluid Power program which may take several years, the enumeration of such requests and placements will not be made a part of the report on the Cooperation of Industry.

To report and summarize the Cooperation of the Fluid Power Industry, the following reports, procedures, and forms will be used.

REPORT IV

Institution ____________________ **Director** ____________________

Summer Institute Committee

A. Membership:

	Name	**Mailing Address**
1.		
2.		
3.		
4.		

B. Activity and Time Spent:

Consultation ______________ **hours**

Assist with Field Trips ______ **hours**

Form 15-66

REPORT V

Institution ______________________ Director ______________________

Guest-Lecturers

Form 16-66

Name	Topic	Mailing Address

Report IV provides for reporting the names and mailing addresses of the members of the Summer Institute Committee, and the hours which they spent in consulting with the Institute Director and in assisting with field trips.

Report V provides for reporting the names, topics, and mailing address of the Guest-Lecturers.

Report VI provides for reporting instructional materials and teaching aids received: name or description of the materials, number of pieces, and name of company and mailing address. The Institute Director will be asked to write a letter of acknowledgement for each shipment. Report VI also provides space to indicate that such a letter was written.

REPORT VI

Institution ______________________ Director ______________________

Instructional Materials and Teaching Aids

Form 17-66

Item	Number Received	Company and Address	Letter of Acknowledgement

The Directors will be asked to complete their reports and send them to the Institute Coordinator at the end of the program so that the information may be summarized. For this purpose, three tables will be used.

Table 16

SUMMER INSTITUTE COMMITTEES: NUMBERS INVOLVED

Activity	Number of Members					
	I	II	III	IV	V	Total
Consultation						
Field Trips						
Guest Lecturers						
Total						

Table 17

SUMMER INSTITUTE COMMITTEES: TIME SPENT

Activity	Hours Spent					
	I	II	III	IV	V	Total
Consultation						
Field Trips						
Guest Lecturers						
Total						

Table 18

INSTRUCTIONAL MATERIAL AND TEACHING AIDS

Item	Number Received					
	I	II	III	IV	V	Total
Catalogs						
Manuals						
Totals						

VII

FOLLOW-UP STUDY OF PARTICIPANTS

Procedures and reports used in follow-up of participants in the 1965 Summer Institutes worked well; with a few minor changes they should prove equally effective in evaluating the 1966 Summer Institutes.

The first of these is a letter from the Institute Coordinator which explains in brief the purpose of the Follow-Up Study, identifies him as the person who will write later for a progress report and a final report, and gives a few simple directions for completing the Check List.

The second is the Check List itself. Two copies will be provided each participant so that he may keep one copy for his own records. The other copy will be collected by the instructor during the last week of the Institute, and sent to the Institute Coordinator.

Directors will be asked to check these copies for complete names, schools, and addresses; and, equally important, to obtain a completed Check List from each participant.

The information reported by these Check Lists will be summarized in tabular form for the final report.

FLUID POWER SOCIETY

P. O. Box 49 THIENSVILLE, WISCONSIN 53092 242-2010

ADDRESS REPLY TO:

Dear Institute Member:

Hopefully, you have enjoyed the fellowship of others, learned a great deal about fluid power, and tentatively formed plans for using your new knowledge.

The real success of the program, of course, is best measured by what you do as a result of participating in this Summer's Institute. And this information will be helpful in planning other programs next year.

You can help by doing three relatively simple things. One, examine the list of activities suggested, and check those which you want to undertake and can do; two, in November, we'll send you a progress report form to fill out and return; and three, we'll send you a final report form in June.

Your cooperation will be greatly appreciated.

Very truly yours,

Fred Lamb, Coordinator
Fluid Power Institutes

FL:I
Enc.

Form 18-66

CHECK LIST
EDUCATIONAL PLANS FOR NEXT YEAR

Name: ______________________ ______________________
First Last

School: ____

School
Address: ____
Number and Street

______________________ ______________________ ________
City State Code

SUGGESTED ACTIVITIES
(Please check one or more)

☐ 1. Introduce a unit of Fluid Power in an existing course

☐ 2. Introduce a course in Fluid Power

☐ 3. Add one or more courses to make a curriculum in Fluid Power.

☐ 4. Add laboratory and demonstration devices to an existing laboratory or shop.

☐ 5. Remodel facilities to provide a separate room, and equip it with laboratory demonstration equipment

☐ 6. Prepare a course of study for:

  ☐ a. An existing unit or course

  ☐ b. A new unit or course

☐ 7. Establish professional relationships with a local or nearby chapter of the Fluid Power Society, and participate in its activities.

☐ 8. Obtain assistance of local members of the Fluid Power Society as:

  ☐ a. An un-official advisory group

  ☐ b. An appointed advisory committee

☐ 9. Involve the advisory group or committee in:

  ☐ a. Constructing courses of study

  ☐ b. Selecting laboratory devices, planning layout of the laboratory

  ☐ c. Selecting instructional materials

  ☐ d. Selecting teaching aids

  ☐ e. Placement of graduates

9. (Continued)

   ☐ f. Other

☐ 10. Prepare an evening program for employed adults.

☐ 11. Work with an education committee to prepare curriculum guides for a city or state.

☐ 12. Other____

____

Institution Attended

____

Date

In November, a brief letter will be prepared and mailed with a copy of the Progress Report, to each participant. The Progress Report will be prepared to show the participant's name, and the activities will be checked which he had selected earlier. Some participants will not respond to the first request for a progress report, and to these a second mailing will be made. Thus, an attempt will be made to obtain a report from each participant.

Data showing progress will be reported in tabular form, and described verbally.

PROGRESS REPORT

Name ______________________________

Form 19-66

Activity	Accom-plished	In Planning Stage	Scheduled for Next Year	Dropped: Reason
☐ 1. Introduce a unit of Fluid Power in an existing course.				
☐ 2. Introduce a course in Fluid Power.				
☐ 3. Add one or more courses to make a curriculum in Fluid Power.				
☐ 4. Add laboratory and demonstration devices to an existing laboratory or shop.				
☐ 5. Remodel facilities to provide a separate room, and equip it with laboratory and demonstration equipment.				
☐ 6. Prepare a course of study for: ☐ a. An existing unit or course				
☐ b. A new unit or course				
☐ 7. Establish professional relationships with a locak or nearby chapter of the Fluid Power Society, and participate in its activities.				
☐ 8. Obtain assistance of local members of the Fluid Power Society as: ☐ a. An un-official advisory group				
☐ b. An appointed advisory committee				
☐ 9. Involve the advisory group or committee in: ☐ a. Constructing courses of study				

Activity	Accomplished	In Planning Stage	Scheduled for Next Year	Dropped: Reason
☐ b. Selecting laboratory devices, planning layout of the laboratory				
☐ c. Selecting instructional materials				
☐ d. Selecting teaching aids				
☐ e. Placement of graduates				
☐ f. Other				
☐ 10. Prepare an evening program for employed adults.				
☐ 11. Work with an education committee to prepare curriculum guides for a city or state.				
☐ 12. Other				

Directions: The activities checked are those which you selected last summer. Please report status of these by checking the appropriate column. Please add any activities not checked but which you have undertaken by placing an (ADD) in the first column; also, report status of these by checking the appropriate column.

Dear Participant:

I hope you received the form mailed to all participants of the 1965 Summer Institutes in Fluid Power.

In case you did not receive one, I am including another form and return envelope for your convenience.

It is most important that we receive the data requested for the follow-up study which will become part of the final report of the U. S. Office of Education.

Would you please take a few minutes to fill out and return this form now?

Thank you for your cooperation.

Frederick W. Lamb
Coordinator

FWL:I
Enc. (2)

Table 20

EDUCATIONAL PLANS: PROGRESS

Activity	Planned	Accomplished	In Planning Stage	Scheduled for Next Year	Dropped
1					
2					
3					
4					
5					
6a					
6b					
7					
8a					
8b					
9a					
9b					
9c					
9d					
9e					
9f					
10					
11					
12					
Totals					

In June of 1967, a Progress Report and covering letter will be mailed to each participant as before, and attempts will be made to obtain 100 percent response. From these, data will be tabulated and described verbally.

Table 21
EDUCATIONAL PLANS: FINAL REPORT

Activity	Planned	Accomplished	In Planning Stage	Scheduled for Next Year	Dropped
1					
2					
3					
4					
5					
6a					
6b					
7					
8a					
8b					
9a					
9b					
9c					
9d					
9e					
9f					
10					
11					
12					
Totals					

VIII

RECOMMENDED PREPARATION AND QUALIFICATIONS OF INSTRUCTORS OF FLUID POWER

With the development of Fluid Power programs in four-year colleges which prepare teachers of Industrial Education; there is a need for working guidelines suggesting content of technical courses; pre-requisite courses in Science and Mathematics; co-requisite courses in such areas as Drafting, Manufacturing Processes, Electronics; for providing and evaluating learning experiences in internships and customer-training programs; and others. Such guidelines would be of immediate assistance to colleges preparing and certifying teachers, and to Boards of Education and officers of community colleges and technical institutes which employ teachers.

To obtain the guidelines needed, it is proposed that the services of William Wolansky be used, an instructor in Wayne's Summer Institute and a doctoral student who has a strong interest in Fluid Power education. Previously, Mr. Wolansky requested a modest sum of money from the Fluid Power Society to work on the teacher education problem which was approved.

During the Spring and Summer terms, Mr. Wolansky can, using interview and questionnaire techniques, assemble and organize the information needed. At the October meeting of the Evaluation Committee and Institute Directors, he would present checking copies of his preliminary work for review, committee deliberation, and action.

Fortunately, for this purpose, those attending the October meeting include representatives of teacher education, Fluid Power education, State boards of education, and city directors of Vocational Education; all are familiar with Fluid Power and highly competent to serve as a special committee on curriculum guidelines.

The guidelines with additions, deletions, and alternations will be included in the final report.

IX

SUGGESTED PROCEDURE FOR INTRODUCING A NEW TECHNOLOGY INTO EDUCATION

As previously stated, the Fluid Power Institute Program is a pilot-experimental program and, as such, its trials and errors successes and failures, should provide guidance to the Office of Education as it is faced with the problem of introducing other emerging technologies into education. In fact, this is the rationale for the expenditure of Federal funds allocated to the program.

To accomplish this objective, the records will need to be examined and experiences reported. This will be done by the administrative staff during the Summer and early Fall, and working copies of this report will be made available to the Evaluation Committee at the October meeting.

It is intended that the report will be so prepared that it could be lifted from the final report and reproduced as a separate document.

X

SUGGESTED OUTLINE

1966 Fluid Power Institute

FINAL REPORT

- **I. Description of the Problem**
  - **A. Emergence of New Technologies**
  - **B. Role of Industry**
  - **C. Summer Institute Programs**
- **II. Planning for Fluid Power Institutes**
  - **A. The Administrative and Coordinating Agency**
  - **B. Preparation of a Proposal**
  - **C. Selection of Institutions**
  - **D. Selection and Appointment of Personnel**
    - **1. Staff**
    - **2. Evaluation Committee**
  - **E. Preparation of Comprehensive Plans**
  - **F. Publicity Media**
  - **G. Planning Conferences**
- **III. Preparation for Fluid Power Programs**
  - **A. Physical Facilities**
  - **B. Program**
  - **C. Participants**
  - **D. Qualifications of Instructors**
- **IV. Supervision and Coordination**
- **V. Evaluation**

- A. Quality of Institute Programs
  - 1. Instructional Content
  - 2. Lecture-Demonstrations
  - 3. Laboratory Experiences
  - 4. Professional Seminar
  - 5. Social-Professional Activities
- B. Cooperation of Industry
- C. Follow-Up Study of Participants

VI. Suggested Procedures for Planning and Conducting Summer Institute Programs

APPENDIX

A. Recommended Preparation and Qualifications of Instructors of Fluid Power

B. Suggested Procedures for Introducing a New Technology Into Education

APPENDIX C

FLUID POWER SOCIETY

P. O. Box 49 THIENSVILLE. WISCONSIN 53092 242-2010

ADDRESS REPLY TO:

College of
Your Choice

ANNOUNCEMENT

1966 SUMMER INSTITUTES ON FLUID POWER

California State College, Los Angeles
Bradley University
Hampton Institute
Trenton State College
Wayne State University

Program:	Basic theory and applications of fluid power; laboratory work; field trips; instructional materials seminar; social and professional activities.
Eligibility:	Now teaching, or will in September, fluid power in high school, vocational school, apprentice program, technical institute, community college, teacher education; did not attend a 1965 Institute on Fluid Power.
College Credit:	Optional; Graduate or Undergraduate.
Living Accommodations:	Dormitory Facilities and food service on or near campus.
Reimbursement:	Travel allowance, 4¢ per mile: Maximum, $16.00. Living Expenses, based on college housing and boarding rates.
Sponsored by:	Office of Education, H. E. W. The Fluid Power Society (Under provisions of the Vocational Education Act of 1963)

Program Requirements:

The Fluid Power Institute is of short duration and intensive. Classroom laboratory work, and field trips require mornings and afternoons. Individual and group study, discussions, and planning of instructional programs and laboratory facilities require most evenings during the week. Social-professional activities are planned for weekends.

While you will find the program highly useful and interesting, there is little time for other activities or responsibilities such as the family, other pursuits, or commuting daily to campus.

To accomplish the purposes of the Institute and to give you maximum technical and professional help, it is necessary that you live on or near the campus, and that you do not bring your family with you - as desirable as this may be. It is understood, in submitting this application, that you accept these conditions.

SUGGESTIONS

1. After completing the application form, check each numbered item again to make sure that you have provided the information needed.

2. To certify that you are eligible to participate, obtain approval and signature of an appropriate school official such as the principal, director, or dean.

3. Mail your application immediately to the Director of the Institute at the college you wish to attend, not to the Society. Use airmail. The number of participants is limited and there will be many more applications than places. Applications will be processed by the Institution, therefore, in the order they are received.

4. The Director of the Institute will notify you when he receives your application, and inform you of the decision made.

MAILING ADDRESSES

Ray Fausel
Director, Fluid Power Institute
California State College
5151 State College Drive
Los Angeles, California 90032

Billy D. Hayes
Director, Fluid Power Institute
Bradley University
1502 W. Bradley Avenue
Peoria, Illinois 61606

John L. Frank
Director, Fluid Power Institute
Hampton Institute
Hampton, Virginia 23368

Vincent Dresser
Director, Fluid Power Institute
Trenton State College
Trenton, New Jersey 08625

Gerald Baysinger
Director, Fluid Power Institute
Wayne State University
Detroit, Michigan 48202

1966 FLUID POWER INSTITUTES

APPLICATION

1. **Date** ______________________

2. **Name** ______________ ______________ ______________
Last First Middle

3. **Telephone** ______________ ______________ ______________
Home School Area

4. **Home Address** ______________________
Number and Street

______________ ______________ ______________
City State Zip Code

5. **School** ______________________

6. **School Address** ______________________
Number and Street

______________ ______________ ______________
City State Zip Code

7. **Eligibility:**

The applicant whose name appears above is now teaching, or will be in September, fluid power (hydraulics and pneumatics).

Signed ______________________

Position ______________________
(Supervisor, Principal, Dean, etc.)

8. Institute Preference: (Please check one)

☐ California State College, Los Angeles: 8/1/66 to 9/2/66

☐ Bradley University: 6/13/66 to 7/15/66

☐ Hampton Institute: 6/20/66 to 7/23/66

☐ Trenton State College: 6/27/66 to 7/29/66

☐ Wayne State University: 6/27/66 to 8/3/66

(OVER)

9. College Credit Desired: (Please check one)

☐ None ☐ Post Degree

☐ Undergraduate ☐ Graduate

10. Admission Requirements: (Please check one)

☐ No college credit desired

☐ I have been admitted to the institution checked above

☐ I have been admitted to the graduate school of the institution checked above

☐ I have not attended this instituion before. Please send me an application.

Signed____________________________________
Applicant

APPENDIX D

Wayne State University
College of Education
Department of Industrial Education

PROGRAM
FLUID POWER INSTITUTE

Director: Gerald Baysinger

Instructors: William F. Gayde
William D. Wolansky

Summer, 1966

TECHNICAL CONTENT

Text: Hedges, Charles S. Industrial Fluid Power Vol. I,
Dallas, Texas: Womack Machine Supply Co., 1965.

Primary Reference: Henke, Russell W. Closing the Loop.
Cleveland, Ohio: Huebner Publications Inc., 1966.

UNITS OF INSTRUCTION

Monday, June 27

8:00 - 9:00 Opening Remarks by William F. Gayde, Instructor

9:00 - 12:00 Introduction to Fluid Power, Max F. Covert, Supervisor Training Section, Salaried Personnel and Training Department, Ford Motor Company

Review Course Outline

Begin Discussion of Basic Laws of Hydraulics

1:00 - 4:00 Discussion of Basic Laws of Hydraulics
Demonstration of Force-Pressure Relationships
Demonstration of GPM-Speed Relationships

Tuesday, June 28

8:00 - 12:00 Discussion of Basic Laws of Hydraulics

1:00 - 4:00 Fittings, Pipe, Hose, Tube, and Fluids

Read: Hedges, pp. 17-25 and p. 35

Wednesday, June 29

8:00 - 12:00 Fluid Conditioners, Guest Lecturer, Laboratory

Mr. Tom McMaster, General Sales Manager, Rosaen Filter Company

Filter, Strainers, Heat Exchangers, etc.

1:00 - 4:00 Hydraulic Symbols and Terms

Read: Hedges, pp. 139-143 also pp. 163-165

Examine Types of Filters and Strainers, Laboratory

Thursday, June 30

8:00 - 12:00 Hydraulic Symbols and Terms

1:00 - 4:00 Field Trip to Ford Rouge Plant

Review designated terms in Glossary of Terms

Friday, July 1

8:00 - 12:00 Introduction to Pumps

1:00 - 4:00 Gear Pumps and Vane Pumps
Double Pumps and Two-Stage Pumps

Read: Hedges, pp. 115-135

Tuesday, July 5

8:00 - 12:00 Piston Pumps

1:00 - 4:00 Flick Reedy Engineering Aids
Presentation: Air Hydraulic Cylinders

Read: Henke, pp. 20-32

Wednesday, July 6

8:00 - 12:00 Flick Reedy Engineering Aids
Presentation: Air-Oil Devices

1:00 - 4:00 Hydraulic Cylinders
Demonstration: Cylinders

Thursday, July 7

8:00 - 12:00 Relief Valves, Laboratory

1:00 - 4:00 Field Trip, Sterling Plant, Ford Motor Company

Read: Hedges, pp. 65-84

Friday, July 8

8:00 - 12:00 Directional Valves

1:00 - 4:00 Single Circuits, Laboratory

Read: Hedges, pp. 84-101

Monday, July 11

8:00 - 12:00 Flow Control Valves

1:00 - 4:00 Flow Control Circuits, Laboratory

Read: Hedges, pp. 41-47

Tuesday, July 12

8:00 - 12:00 Pressure Controls

1:00 - 4:00 Pressure Controls, Laboratory

Read: Hedges, p. 75

6:00 Flick Reedy Bus: Demonstrations, Pneumatics and Air-Oil Devices

Wednesday, July 13

Vickers Hydraulics School

8:30 Welcome and Introduction

8:45 Movie, "Hidden Giant"

9:15 - 12:00 Demonstration Laboratory
1. Cavitation
2. Aeration
3. Pump Volumetric Efficiency

Activities
Vane Pump Assembly and Disassembly
Functional Test of Assembled Unit

1:00 Pressure Controls
1. Simple Relief Valve
2. Compound Relief Valve
    (a) Venting Relief Valve
    (b) Two-Pressure System

3:00 Pressure Controls
Pressure-Reducing Valve

4:00 Demonstration, Laboratory
1. Relief-Valve Operation
2. Pressure-Reducing Valve Operation

Activity
Valve Assembly and Disassembly

Thursday, July 14

Vickers Hydraulic School

8:30 Pressure Controls, "R" Valve
1. Relief-Valve Application
2. Sequence Application
3. Unloading Application

11:00 - 12:00 Laboratory
Circuitry Buildup

1:00 Laboratory, Continued

3:00 - 5:00 Pressure Controls, "R" Valve
1. Counterbalance Application
2. Brake Application

Friday, July 15

Vickers Hydraulic School

8:30 Servo Valves
1. Types
2. Operation

10:45 Demonstration, Laboratory

11:45 - 12:15 Travel to A&E Center

1:00 Plant Tour

3:00 Return to School

3:45 - 5:00 High Pressure Sequence Circuits

Monday, July 18

8:00 - 12:00 Boosters and Accumulators

1:00 - 4:00 Construction and Use of Boosters,
Laboratory

Read: Hedges, pp. 151-158

Tuesday, July 19

8:00 - 12:00 Basic Laws of Pneumatics

1:00 - 4:00 Basic Laws of Pneumatics, Laboratory
Discussion of Symbols and Terms

Read: Hedges, pp. 41-43

Wednesday, July 20

8:00 - 12:00 Compressors and Receivers

1:00 - 4:00 Filters, Lubricators, and Regulators

Read: Hedges, pp. 143-150

Thursday, July 21

8:00 - 12:00 Pneumatic Devices

1:00 - 4:00 Pneumatic Actuators, Laboratory

Read: Hedges, pp. 37-39

Friday, July 22

8:00 - 12:00 Pneumatic Valves

1:00 - 4:00 Field Trip, F. Joseph Lamb Company

Read: Hedges, pp. 103-106

Monday, July 25

8:00 - 12:00 Pneumatic Valves

1:00 - 4:00 Disassembly and Assembly of Pneumatic Valves, Laboratory

Tuesday, July 26

8:00 - 12:00 Pneumatic Valves

1:00 - 4:00 Guest Lecturer
Mr. Colley, Colley and Schlee Inc.,
Fluidic Developments

Wednesday, July 27

8:00 - 4:00 Pneumatic Circuits
Guest Lecturer
James Neff, Vice President, Mac Valve Company
Review: Hedges, pp. 103-106

FLUID POWER SEMINAR

Summer, 1966

Objectives

Develop ability to critically examine and establish realistic objectives for a specific level of instruction in fluid power.

Become familiar with content analysis and job analysis as techniques for deriving curriculum content in a technical area such as fluid power.

To gain first hand experience in reviewing, analyzing, developing, selecting, and structuring needed outlines, audio-visuals, and other instructional materials.

To become familiar with recent and appropriate instructional resources available to the instructor in fluid power.

Organization

1. Participants will be grouped by school level; high school; vocational school; technical institute and community college; and four year college.
2. Participants will meet Monday and Friday, 7:00 to 9:00 p.m. Groups will meet two other evenings per week by arrangement.
3. Each of the four groups will be responsible for:
   - (a) Develop an outline for a course in fluid power.
   - (b) Select and review a text.
   - (c) Select and review films.
   - (d) Examine, evaluate, and select laboratory equipment, tools, supplies, and safety equipment.
   - (e) Develop a laboratory layout for:
     - (1) An existing shop or room or
     - (2) A new room.

(f) Develop an article for publication in one of the professional journals including:

Equipment needed,
Cost of equipment and tools,
Laboratory layout,
Qualifications of the instructor,
Instructional materials, and
Sources of such materials.

4. Each group will provide one bound copy of the report to WSU, and two copies for each member in the group.

Report should include:

(a) Course outline.
(b) Text, films, equipment lists, vendors, costs.
(c) Laboratory layout (individual).

Units of Instruction

Monday, June 27

7:00 - 9:00 Review course outline. Preparing objectives for fluid power instruction.

Assignment: Read Mager. Chapters 1-4.

Make a trial run in preparing objectives for your specific level of instruction.

Wednesday, June 29

7:00 - 8:00 Discuss objectives and finalize these within each group

8:00 - 9:00 Analysis Technique.
Job analysis.
Content analysis.

Assignment: Read Fryklund, Chapter 1 and Chapter 10.

Begin to review available outlines, text and reference materials.

8:30 - 9:00 Laboratory layout. Discussion of facilities, space, placement of equipment, demonstration areas, and storage.
Hand-out material--specifications and guide to laboratory planning.

Wednesday, July 20

6:30 - 8:15 Preparing manuscript for publication.

8:15 - 9:00 Group work on course outlines
Hand-out materials--Pointers for preparing a manuscript
--Writing Technical Reports
--Evaluation of Simulators

Monday, July 25

6:30 - 8:00 Evaluating laboratory equipment and devices. Preparation of equipment, tools, and material lists.

8:00 - 9:00 Work session on course outlines. Discussion and evaluation of outlines by each group.
Hand-out material--follow-up instrument.

Wednesday, July 27

6:30 - 8:00 Brief group report of instructional materials prepared.
All assignments are due.

8:00 - 9:00 Discussion and refinement of article for publication.

Social and Professional Program

June 27 to July 3

International Freedom Festival

See attached schedule of events. Unusual events have been highlighted. Select those activities that interest you.

Monday, July 4

10:00 - 5:00 Canadian Tour

Sunday, July 10

1:00 - 3:00 Group tour--Detroit Institute of Arts

Saturday, July 16

9:30 - 4:30 Car Pool--Greenfield Village and Ford Museum

Saturday, July 23

1:00 - 4:00 Car Pool--Cranbrook Institute of Science

Sunday, July 24

12:00 Noon Car Pool--Metropolitan Beach

Tuesday, July 26

7:30 - 9:00 Henry Ford Community College

Thursday, July 28

12:00 Noon - 2:00 Luncheon, McGregor Community Center

Tuesday, July 5

7:00 - 9:00 Evaluation of instructional aids

Wednesday, July 6

7:00 - 8:00 Discussion of course outline construction

8:00 - 9:00 Evaluation of text materials
Hand-out material--form listing criteria
to be used.

Thursday, July 7

7:00 - 9:00 Introduction, discussion, and demonstration of fluid power simulators for schools by Mr. Edward Konopka

Monday, July 11

7:00 - 8:00 Select and review slides, films, transparencies, and other audio-visuals.

8:00 - 9:00 Group work on determination and evaluation of selected objectives.
Hand-out material--form listing criteria
to be used.

Wednesday, July 13,

7:00 - 8:00 Flick-Reedy Mobile Pneumatic Demonstration

8:00 - 8:30 Mr. Fred Lamb, Coordinator of Fluid Power Institutes

8:30 - 9:00 Evaluation

Monday, July 18

7:00 - 8:30 Lecture on circuits and fluid power instructional programs in industry by Messrs. John Sherer and Lee Burza.

Thursday, July 28

8:00 - 12:00 Vickers Hydraulics

Test and Evaluate a New Simulator

1:00 - 4:00 Fluids, Air Embullism
Guest Lecturer
Donald K. Davis, Davis Hydraulic Sales and Service

Read: Hedges, p. 35

Friday, July 29

8:00 - 12:00 Simulator Circuits, Laboratory

1:00 - 4:00 Final Examination

Note: Other assignments will be scheduled daily by the instructor.

TIME ALLOCATIONS

Lecture - Demonstration	
Hydraulics	61
Pneumatics	53
Laboratory Work	48
Field Trips	16
Seminar	24
Social-Professional Activities	32
Total	234 hours

APPENDIX E

TABLE I

Bradley University

Name	School	School Address
Bartels, Francis	Pardeeville High School	Pardeeville, Wisconsin
Chechopoulos, Steve	Kenosha Technical Institute	625 52nd Street Kenosha, Wisconsin
Garrett, Jack	Peoria High School	Peoria, Illinois
Guengerich, Ronald	Morton West High School	2400 Home Avenue Berwyn, Illinois
Hood, Charles D.	Glenbard East High School	Lombard, Illinois
Lokken, Ronald	Austin Area Vocational School	Austin, Minnesota
Marks, Eugene	Freeport Senior High School	Freeport, Illinois
Mathis, Jack	Fayetteville Senior High School	Fayetteville, Arkansas
Petersen, John	Granite Falls Technical Institute	760 7th Avenue Granite Falls, Minnesota
Beck, Bruce	Thornridge High School	Dalton, Illinois
Robinson, Charles,	East Side High School	Cleveland, Mississippi
Schilling, William F.	Eastridge High School	Kankakee, Illinois
Steen, Carl	Lexington High School	Lexington, Ohio
Taylor, Houston Jr.	Industrial Art Dept. University of Arkansas	Fayetteville, Arkansas
Vogel, Henry	Austin Area Vocational School	Austin, Minnesota

TABLE I

BRADLEY UNIVERSITY

Name	School	School Address
Wenig, Robert	Indiana State University	Terre Haute, Indiana
CANADIAN TEACHERS		
Kent, D. "Mel"	Morse Place Junior High School	East Kildonan Winnipeg, Canada
Olynyk, Michael	John Taylor Collegiate	Hamilton d Knox St. Charles, Manitoba
Reid, Frank	Manitoba Institute of Technology	2055 Notre Dame Ave. Winnipeg, Manitoba
Wilson, Trueman	Salisburg Regional High School	Veterans' Avenue Salisburg N.B.

TABLE II

CALIFORNIA STATE COLLEGE AT LOS ANGELES

Name	School	School Address
Beardsley, James	San Joaquin Delta College	3301 Kensington Stockton, California
Blinn, James E.	Ormsby County High School	Fall & King Street Carson City, Nevada
Brockman, Dennis B.	Alhambra High School	101 S. Second Street Alhambra, California
Cousley, Charles B.	Delgado Institute	615 City Park Avenue New Orleans, Louisianna
Gornall, Robert J.	Alberni District Secondary School	1300 Burde Street Port Alberni, B.C. Canada
Hallenbeck, Harvey G.	Yuba College	Beale Road & Linda Ave. Marysville, California
Leeds, Robert	Lompoc Unified High School	College & M Street Lompoc, California
Miccio, Frank	McKee Vocational & Technical High School	290 St. Mark's Place Staten Island, New York
Ortiz, John W.	Flint Community Junior College	1401 E. Court Street Flint, Michigan
Saunders, Allan J.	Clarence Fulton Senior Secondary School	Technical Branch Polson Park Vernon, B.C. Canada
Thomas, Richard	Rio Hondo Junior College	Workman Mill Road Whittier, California

TABLE III

HAMPTON INSTITUTE

Name	School	School Address
Armstead, Arthur J.	George Wythe High School	Gloucester Street Hampton, Virginia
Berry, Warnell	Howard High School	Georgetown, South Carolina
Bolling, Edward A.	United States Aid	Langus, Nigeria Africa
Burrell, John F.	I.C. Norcum High School	2900 Turnpike Road Portsmouth, Virginia
Dailey, Johnnie	Booker High School	Sarasota, Florida
Edwards, Carlton	Lucy Addison High School	1220 5th Street, N.W. Roanoke, Virginia
Gilliard, Joseph W.	Hampton Institute	Hampton, Virginia
Gray, William	T. Benton Gayle High School	Falmouth, Virginia
Greene, John W.	Phelps Vocational High School	24th & Benning Road, N.E. Washington, D.C.
Harris, Samuel E.	Sumner High School Voc. Mech. Shop	8th & Oakland Avenues Kansas City, Kansas
Lewis, William R.	Douglas High School	East Liberty Street Leesburg, Virginia
Jones, William L.	Huntington High School	Orcutt Avenue Newport News, Virginia
McGhee, Samuel C.	Hampton Institute	Hampton, Virginia
Miller, Edwin H.	I.C. Norcum High School	2900 Turnpike Road Portsmouth, Virginia
Moody, Leonard C.	Stephen Foster School	2500 Collingwood Road Alexandria, Virginia

TABLE III

HAMPTON INSTITUTE

Name	School	School Address
White, Earle L.	Bell Vocational High School	3415 Hlatt Place, N.W. Washington, D.C.
Williams, Raymond P.	A & T College of North Carolina	212 Dudley Street Greensboro, North Carolina

TABLE IV

TRENTON STATE COLLEGE

Name	School	School Address
Amdur, Philip	Rahway High School	Rahway, N.J.
Bayley, Francis Louis	Charlotte Amalie High School	St. Thomas, Virgin Islands
Hadley, Peter	C.H. Boehm High School	Yardley, Penna.
Jones, Merwin Miller	Syracuse Central Technical High School	Syracuse, N.Y.
Kent, Robert S.	Norwalk State Technical Institute	South Norwalk, Conn.
Maloney, David J.	Trenton State College	Trenton, N.J.
Papp, Alexander G.	Ewing High School	Ewing Twsp., N.J.
Romansky, Joseph J.	Trenton State College	Trenton, N.J.
Serwell, Thomas John	Trenton State College	Trenton, N.J.
Targonski, Edward A.	Trenton State College	Trenton, N.J.
Trent, Graham Allen	Elizabeth City State College	Elizabeth City, North Carolina

TABLE V

WAYNE STATE UNIVERSITY

Name	School	School Address
Bengtson, Carol Dean	Nebraska Vocational Technical School	Milford, Nebraska
Bowman, Dale Earnest	Hayes High School	Euclid Avenue Delaware, Ohio
Bradford, James	Sabine High School	Many, Louisiana
Burkholder, Carroll C.	Muskegon County Community College	Hackley Building Muskegon, Michigan
Butala, John Jr.	Georgia Southern College	Statesboro, Georgia
Carter, Richard Carting	Gorham State College	Gorham, Maine
Curtis, Robert Willard	Michigan Technological University--Sault Branch	Sault Ste. Marie, Michigan
Dellinger, James J.	Clinton Prairie High School	R.R.6 Frankfort, Indiana
Gortat, Thomas Anthony	Monroe High School	Monroe, Michigan
Hammond, Richard H.	Granite Falls High School	Granite Falls, Minnesota
Jarvis, Dale Kenneth	South Eastern Indiana Area Vocational School	Versailles, Indiana
Paige, F. Theodore	Ohio University	Department of Industrial Education Athens, Ohio
Rappaport, Louis G.	Monroe High School	Monroe & Fifth Streets Monroe, Michigan
Simoneau, George Bernard	Erie County Technical Institute	Main & Youngs Road Buffalo, New York

TABLE V

WAYNE STATE UNIVERSITY

Name	School	School Address
Theuerkauf, John O.	St. Johns Public Schools	101 Cass St. Johns, Michigan
Timm, Jerry Paul	Alpena High School	Alpena, Michigan

WAYNE STATE UNIVERSITY
DEPARTMENT OF INDUSTRIAL EDUCATION

A STUDY OF FLUID POWER TECHNOLOGY AT THE HIGH SCHOOL LEVEL WITH SUGGESTIONS FOR COURSE DEVELOPMENT

Prepared by:

Dale Bowman
James Bradford
James Dellinger
Richard Hammond
John Theuerkauf
Jerry Timm

July, 1966

INTRODUCTION

During the summer quarter of 1966, a Fluid Power Institute seminar was held at Wayne State University as a part of the instructional program. Participants were grouped according to a particular instructional level, namely: secondary school, vocational high school, technical institute and community college, and teacher education. Each group was required to evaluate available materials and develop an instructional program which could be used at their institution. This project was to include a course of study, selection of a text book, list of references, list of audio visual materials, evaluation instrument for the selection of equipment, a list of tools, and a laboratory layout.

Participants teaching at the secondary school level prepared this report as a group project. It should be remembered that this was an initial effort and written during an intensive program of instruction in fluid power technology. It is therefore, a proposed introductory course and not a curriculum. As such, it is the first step in organizing an instructional program geared to a specific level of instruction, in this case, for secondary school level. To structure a program for a specific level of instruction was essentially the major objective of the seminar. This prepared program is to serve as a springboard for further development and refinement of curriculum materials in fluid power technology.

William Wolansky
Instructor

PREFACE

This outline was organized during the five week, 1966 Fluid Power Institute, at Wayne State University in Detroit, Michigan.

It was organized by six high school teachers who have taught or will be teaching introductory courses in fluid power.

Many hours of work went into the compilation of film lists, analysis of text books and references, reviewing previous outlines, using different training simulators, and touring industries, to come up with what should appear to be a practical course outline on the secondary school level.

It is the writers' hope that this outline will be of help to other high school teachers planning to introduce a course in fluid power.

We realize revisions and additions will have to be made to meet specific needs and resources, and also to keep up with the growth and development in the fluid power industry.

Some resources may have been overlooked due to the short time spent at the Institute. However, we have found industry very cooperative and strongly suggest contact be made, at least locally, asking for cooperation in securing equipment and teaching aids, and in scheduling field trips.

TABLE OF CONTENTS

Introduction. . . . . Page i

Preface. ii

Introduction to Fluid Power. 1

Description of Content Outline. 3

Evaluation of Textbook. 7

Supplementary Text. 8

References. 9

Films, Film Strips and Transparencies. . . 11

Tools and Equipment. 16

Laboratory Layout. 17

Instructional Aids. 18

WHAT IS FLUID POWER?

Fluid Power is a system that generates, transmits, and controls power through the use of a contained fluid under pressure.

OBJECTIVES OF FLUID POWER IN THE SECONDARY SCHOOL

1. To develop an understanding of the application and importance of fluid power.
2. To introduce the physical laws of science and mathematics as applied to fluid power.
3. To acquaint students with the fluids and components used in fluid power.
4. To acquaint the student with terms, symbols, and schematics of fluid power.
5. To provide experiences in setting up and operating fluid power systems.
6. To develop an understanding of safety in fluid power.

CONTENT OUTLINE

I. Introduction to fluid power

- A. History and applications of fluid power
- B. Basic Laws of fluid power
  - 1. Pascal's Law
  - 2. Boyles' Law
  - 3. Charles' Law
- C. Definition of terms and symbols
- D. Safety rules

II. Hydraulic fluids

- A. Classifications
  - 1. Petroleum base oils
  - 2. Fire resistant oils
  - 3. Other oils
- B. Characteristics of oil
  - 1. Viscosity
  - 2. Additives
- C. Handling precautions

III. Reservoirs

- A. Purpose and function of reservoirs
- B. Types of reservoirs
  - 1. Pressurized
  - 2. Open reservoirs
- C. Design requirements
- D. Care and maintenance
- E. Symbols

IV. Conductors

- A. Pipes, sizes and measurements
  - 1. Standard
  - 2. Extra heavy
  - 3. Double extra heavy
- B. Hoses
  - 1. Plastic hose
  - 2. Rubber hose
  - 3. Fabric woven hose
  - 4. Wire wound hose
- C. Tubing
- D. Connectors and fittings
- E. Symbols

V. Pumps and prime movers

- A. Purpose of pumps
- B. Classification
  - 1. Non-positive displacement
  - 2. Positive displacement
- C. Types of pumps
  - 1. Gear
  - 2. Vane
  - 3. Piston
- D. Pump symbols
- E. Prime movers
  - 1. Elect motor
  - 2. Gas engine
  - 3. Other sources

VI. Valves and their functions

- A. Purpose of valves
- B. Classifications
  - 1. Relief valves
  - 2. Directional valves
  - 3. Flow control valves
- C. Types of valves
  - 1. Relief valves
    - a. Simple
    - b. Compound
  - 2. Directional control valves
    - a. Position
      - 1. Two-position
      - 2. Three-position
    - b. Ways
      - 1. Two-way
      - 2. Three-way
      - 3. Four-way
    - c. Control
      - 1. Manual
      - 2. Solenoid
      - 3. Mechanical
      - 4. Pilot
      - 5. Solenoid-pilot
    - d. Spring condition
      - 1. No spring
      - 2. Spring-centered
      - 3. Spring-offset
    - e. Center condition
      - 1. Open
      - 2. Closed
      - 3. Tandem
      - 4. Other special centers
  - 3. Flow control valves
    - a. Needle valve
    - b. Glove valve
    - c. Gate valve
    - d. Check valve

VII. Actuators - Linear

A. Definition
B. Purpose
C. Types of Cylinders
  1. Single-acting cylinder
  2. Double-acting, single rod
  3. Double-acting, double rod
D. Mountings
  1. Foot mount
  2. Flange mount
  3. Hinge mount
  4. Trunnion mount
  5. Other mounts
E. Seals
  1. Piston ring
  2. Flat-cup
  3. O-Ring
  4. Various other seals

VIII. Actuators - Rotary

A. Definition
B. Purpose
C. Types of Motors
  1. Gear-type
  2. Vane-type
  3. Piston-type
D. Mountings
  1. Flange-mount
  2. Face-mount
  3. Other mountings
E. Seals and Packings
  1. O-Ring
  2. U-Cup
  3. Other seals

IX. Components and their relationship in a Circuit

A. Symbols and schematics
B. Basic circuits
C. Accessory components
  1. Heat exchangers
  2. Accumulators
  3. Reservoir accessories
    a. Filter
    b. Breather cap
    c. Oil level gauge
    d. Baffle

X. Basic Principles of Pneumatics

A. Introduction
B. Physical laws and fundamentals

- C. Compressors
    - 1. Classification
        - a. Positive displacement
        - b. Dynamic type
- D. Components
    - 1. Filter
    - 2. Regulator
    - 3. Lubricator
    - 4. Controls
        - a. Pressure
        - b. Directional
        - c. flow
    - 5. Actuators
        - a. Linear
        - b. Rotary
- E. Symbols
- F. Pneumatic circuits

XI. Combination of hydraulic and pneumatic circuits

SUGGESTED TEXT BOOK

1. Industrial Fluid Power Text Volume I, by Charles Hedges was selected as a text for its simplicity and basic manner in which it covers Pneumatics and Hydraulics necessary on the Secondary Level.

Note: The address of this book will be found in the Reference book list.

SUPPLEMENTARY TEXTS

Industrial Fluid Power Text, Charles Hedges. Womack Machine Supply Co., 2010 Shea Road, Dallas, Texas, 75235.

Closing the Loop, Russell Henke. Milwaukee School of Engineering, Milwaukee, Wisconsin.

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FILMS

"Airplane Hydraulic Brakes: Types, Construction and Action"	30 min/16 mm Black and White	Civil Aeronautics Administration
"Application of Pascal's Law, Part I"	15 min/16 mm Color	United World Films Gov't Films Dept. 1445 Park Avenue New York 29, N.Y
"Application of Pascal's Law, Part II"	15 min/16 mm Color	United World Films Gov't Films Dept. 1445 Park Avenue New York, N.Y.
"Automation Today"	15 min/16 mm Black and White	Ford Motor Company Supervisor Training Dept.
"Basic Hydraulics"	15 min/16 mm	United World Films Gov't Films Dept. 1445 Park Avenue New York 29, N.Y.
"Basic Principles of Hydraulics"	15 min/16 mm	Jam Handy Organization 2821 S. Grand Blvd. Detroit 12, Michigan
"Controlled Power"	20 min/16 mm Black and White	Vickers, Inc. P.O. Box 32 Detroit, Michigan
"The Hidden Joint"	25 min/16 mm	Vickers, Inc. P.O. Box 32 Detroit, Michigan
"Fluid Flow in Hydraulic Systems"	25 min/16 mm	United World Films Gov't Films Dept. 1445 Park Avenue New York 29, N.Y.
"Harnessing Liquids"	12 min/16 mm Black and White	Shell Oil Company
"Hydraulic Insurance"	12 min/16 mm	Texas Oil Company
"Hydraulic Turret Traversing Mechanism"	22 min/16 mm	The Oil gear Co. 1560 W. Pierce St. Milwaukee 4, Wisc.

"Hydraulic Valves Methods of Operating Valves:"	Slide Film 50 Frames	Civil Aeronautics Administration
"Our Industrial Air Power"	28 min/16 mm Black and White	Quincy Compressor Quincy, Illinois
"Techniques for Tomorrow"		Ford Motor Co. Supervisory Training Dept.
"This Automation"		Ford Motor Co. Supervisory Training Dept.
The U.S. Air Force and Navy Training film on Fluid Power "Power up"	15 min/16 mm	Denison Engineering Division Box 713 Lima, Ohio

FILM STRIPS

"Elements of Compressed Air" - Parker-Hannifin Corp., Cleveland Ohio.

"Cylinder Selection and Application Considerations" - Parker-Hannifin Corp., Cleveland, Ohio.

"Elements of Hydraulics" - Parker-Hannifin Corp., Cleveland, Ohio.

"Elements of Compressed Air" - Parker-Hannifin Corp., Cleveland, Ohio.

"Hydraulic Fittings" - Parker-Hannifin Corp., Cleveland, Ohio.

"Pneumatic Circuitry" - Parker-Hannifin Corp., Cleveland, Ohio.

"Preparing Air for Use" - Parker-Hannifin Corp., Cleveland, Ohio.

"Air Control Technics" - Double A Products, Co., Manchester, Michigan.

SLIDES

"Basic Automation" - 25 2 x 2 slides, Double A Products Co., Manchester, Michigan.

"Directional Control Valves" - 20 2 x 2 slides, Double A Products Co., Manchester, Michigan.

"Fluid Power Component and Circuit Series" - (Slide Series) Kenosha Technical Institute.

"Fluid Power: The Muscles and Nerves of Modern Industry" - 30 2 x 2 slides, Modernaire Corporation, San Leandro, California.

"Press Circuits" - 9 2 x 2 slides, Double A Products Co., Manchester, Michigan.

"Pumps and Motors" - (Slide Series) Double A Products Co., Manchester, Michigan.

TRANSPARENCIES

Vega Hydraulic Power Training
Box 1006
Decatur, Illinois

Electromatic Manfacturing Co., Inc.
Box 183
McMinnville, Tennesee

These two sets of transparencies can be used at the high school level; the price range is from $100.00 - $200.00.

TOOLS AND EQUIPMENT

A. Equipment
   1. Commercial Simulators
   2. Portable pumping unit
   3. Benches
   4. Hoses
   5. Quick dis-connects and fittings
   6. Assortment of components
      a. cylinders
      b. motors
      c. valves
      d. others
   7. Air compressor and components
   8. Tachometer
   9. Pressure gauges
   10. Covered trash can

B. Tools
   1. Combination wrenches (open-end, box-end)
   2. Pliers (variety)
   3. Assortment of pipe wrenches
   4. Flaring tools
   5. Adjustable wrenches (assorted sizes)
   6. Screw drivers
   7. Hack saws
   8. Pipe cutters
   9. Vises
   10. Ball pein hammers
   11. Mallets
   12. Snap ring plier set
   13. Tap and die set
   14. Pipe threading set
   15. Tube benders
   16. Tin snips

All machine tools should be adaptable to hydraulic or pneumatic controls.

LABORATORY EQUIPMENT

Equipment cost should not be a deterrent to starting fluid power in a school; most schools have an air compressor which will provide a power source as a starting point for introducing this subject.

A few fluid power classes being taught have originated with equipment from the local automobile "grave yards". Instructors are teaching hydraulics using equipment like hydraulic brakes, power steering units, and others.

Six companies now build simulators for school use. Only three build both air and oil units.

Both hydraulic and pneumatic equipment should be available but due to the noise of the simulator's compressor, it is recommended that you use your school compressor, if available.

Quick disconnects are recommended to conserve time in hook up. Portability of simulators should be considered for the following reasons: demonstration by the teachers, experiments by students, testing of circuitry, possibility as a power source for adapting fluid power to tools in the shop to illustrate applications.

We have grouped the simulators as follows:

For introductory courses:

1. Vega
   Box 1006
   Decatur, Ill.

2. Technical
   542 Hilton Rd.
   Ferndale, Mich.

3. Electromatic
   Box 183
   McMinnville, Tenn.

For advanced courses:

1. Scott
   Pompano Beach, Fla.

2. Capital
   2020 W. 78th St.
   Minneapolis, Minn.

3. Vickers
   14420 Linwood Ave.
   Detroit, Mich.

Besides simulators, a larger motor and pump testing stand with instrumentation could well be used to test various pumps before and after disassembly and assembly by students.

The instructor should collect various components for disassembly and assembly.

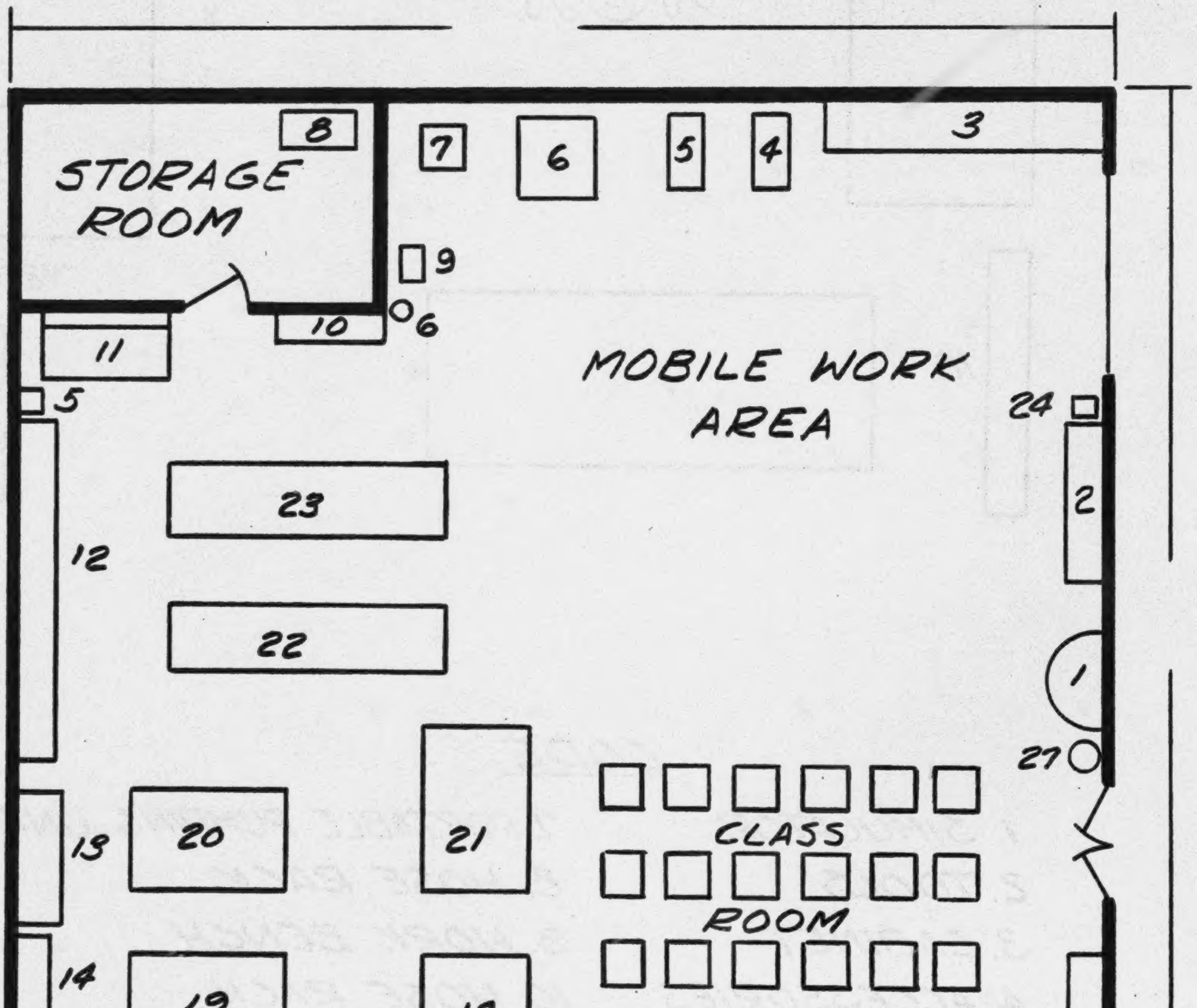
Expensive and elaborate equipment is not essential to this course. You may make your own simulators.

INSTRUCTIONAL AIDS

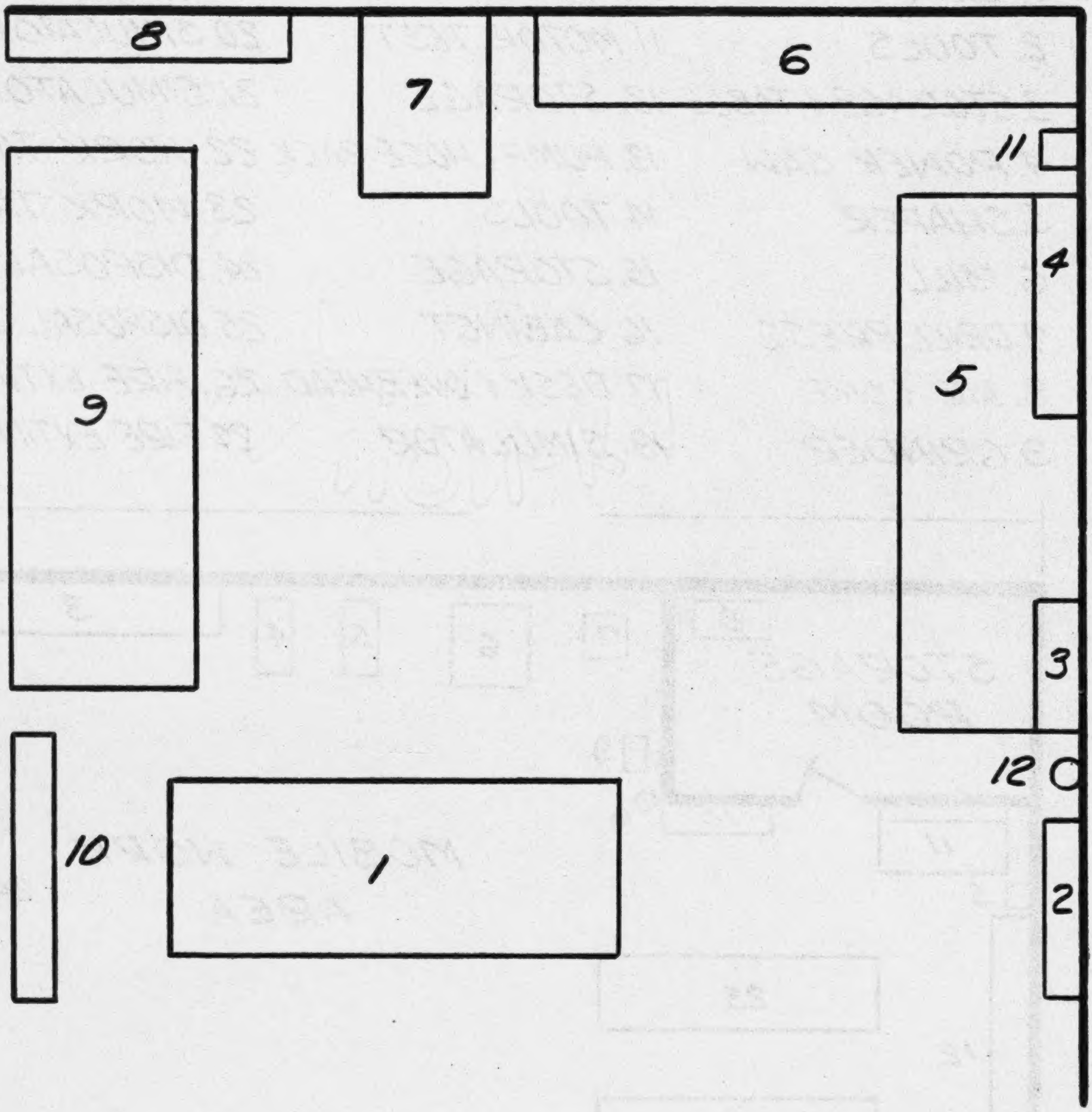
1. Overhead Projector
2. Film Strip projector
3. Movie projector
4. Cutaways
5. Transparencies
6. Fieldtrips
7. Guest speakers

COMPREHENSIVE SHOP

1. SINK
2. TOOLS
3. STORAGE & TABLE
4. POWER SAW
5. SHAPER
6. MILL
7. DRILL PRESS
8. AIR COMP.
9. GRINDER
10. TOOLS
11. MOTOR TEST
12. STORAGE
13. PUMP & HOSE RACK
14. TOOLS
15. STORAGE
16. CABINET
17. DESK & OVERHEAD
18. SIMULATOR
19. SIMULATOR
20. SIMULATOR
21. SIMULATOR
22. WORK TABLE
23. WORK TABLE
24. DISPOSAL CONTAINER
25. DISPOSAL CONTAINER
26. FIRE EXTINGUISHER
27. FIRE EXTINGUISHER


8
STORAGE ROOM
7
6
5
4
3
9
10
6
11
5
MOBILE WORK AREA
24
2
23
12
22
1
27
20
13
21
CLASS ROOM
14
19
18
17
LIB.
15
16

UNIT SHOP



CODE

1. SIMULATOR	7. PORTABLE PUMPING UNIT
2. TOOLS	8. HOSE RACK
3. CABINET	9. WORK BENCH
4. ACCESSORIES	10. HOSE RACK
5. WORK BENCH	11. DISPOSAL UNIT
6. COMPONENT STORAGE	12. FIRE EXTINGUISHER

WAYNE STATE UNIVERSITY
DEPARTMENT OF INDUSTRIAL EDUCATION

HYDRAULICS IN MACHINIST TECHNOLOGY

Prepared by:

Carol Bengtson
Louis Rappaport
Thomas Gortat
Dale Jarvis

July, 1966

INTRODUCTION

During the summer quarter of 1966, a Fluid Power Institute seminar was held at Wayne State University as a part of the instructional program. Participants were grouped according to a particular instructional level, namely: secondary school vocational high school, technical institute and community college, and teacher education. Each group was required to evaluate available materials and develop an instructional program which could be used at their institution. This project was to include a course outline, selection of a textbook, list of references, list of audio-visual materials, developing an evaluation instrument for the selection of equipment, a list of tools, and a laboratory layout.

Participants teaching at the vocational and technical school level prepared this report as a group project. It should be remembered that this was an initial effort and it was written during an intensive program of instruction in fluid power. The five-week seminar provided insufficient time to develop an instructional program in depth. It is therefore, a proposed introductory course and not a curriculum. As such, it is the first step in organizing an instructional program geared specifically to mechanical technology engineering at the vocational or technical school level. To structure a program for a specific level of instruction was essentially the major objective of the seminar. This prepared program is to serve as a springboard or background for further development and refinement of more advanced courses and curriculum materials in fluid power technology.

William Wolansky
Instructor

PREFACE

The course outline of Hydraulics in Machinist Technology was prepared as a part of a course of study in Fluid Power at Wayne State University under the direction of Associate Professor Gerald Baysinger, William Gayde - Institute Instructor, William Wolansky - Seminar Instructor. This course of study was completed in partial fulfillment of a six week summer institute under the sponsorship of the U.S. Department of Education and administered by the Fluid Power Society.

This course outline is intended to promote the teaching of Hydraulics in Machinist Technology in a secondary or post secondary school system. It is intended to assist the school administrator in evaluating the need and worth of the program. Counselors may use this outline as a tool of mensuration to properly place and advise prospective candidates. It is intended to provide the teacher of Hydraulics in Machinist Technology with a specific program of instruction and evaluation of subject matter. In essence, it is a description of the content for purposes of the student, parent, teacher, counselor and administrator.

TABLE OF CONTENTS

1. Preface. . . . .
2. Table of Contents. . . . .
3. Program of Studies of Hydraulics in Machinists Technology . . . .
4. Objectives of Hydraulics as used in Machinists Technology . . . .
5. Description of Hydraulics in Machinists Technology . . . .
6. Specific Purpose of Hydraulics in Machinists Tecnology . . . .
7. Teaching Guide for Hydraulics in Machinists Technology. . . . .
8. Suggested Tool List - Student Issue . . . .
9. Suggested Shop Tools . . . .
10. Suggested Instructional Equipment . . . .
11. Suggested Instrumentation . . . .
12. Audio-Visual Equipment. . . . .
13. Suggested Classroom Equipment . . . .
14. Floor Plans. . . . .
15. List of Available Textbooks. . . . .
16. Films . . . .
17. Film Strips and slides. . . . .

The Objectives of Hydraulics as used in Machinist Technology

1. To develop an understanding and importance of the hydraulics in the machine tool industry.
2. To acquaint the student with the basic components and equipment as used in the machine tool industry.
3. To provide work experiences that will enable the student to be employable in the area of hydraulics in the machine tool industry.
4. To introduce the student to the applicable physical laws of science and mathematics as used in hydraulics in the machine tool industry.
5. To develop an understanding of safety in hydraulics as used in the machine tool industry.

Hydraulics in Machinist Technology

Program of Studies

The program of studies is a 6 week course based on 6 hours per day, 30 hours per week for a total of 180 clock hours. It consumes ½ of the 5th quarter of machinist technology and is offered as an integral part of this course.

Hydraulics in Machinist Technology will serve as a foundation in preparing the student for entrance into the trade as a hydraulic installer, maintenance, man, bench hand, technician, or apprentice.

The student will be provided work experiences in the use of the controls; how to install, maintain, and operate hydraulic systems. In tool rooms this will include collant systems, hydraulic grinders, lathe and mills, machine tracer systems. Also he will be provided work experiences on hydraulic panel system and the bench.

Supporting courses in this hydraulic program are: Related training in machinist technology, power machinics, Ind. Math, Mech. Dwg, and electricity. Preferred supporting courses for the Hydraulic Technology or Pre-apprentice student are: Applied Science, Physics, Advanced Algebra, Geometry and Trigonometry.

Description of Hydraulics in Machinist Technology

The student will learn how to: draw symbols and schematics, assemble transmission lines using quick disconnects - pipe-hose - tubing, design a reservoir assemble 3 types of pumps, use directional valves, use 3 types of valves to control flow of fluid, use 5 types of valves to control pressures for specific functions, assemble a cylinder, use a cylinder to do a mechanical job, diagram a basic circuit, assemble a complex circuit on a simulator, test the 4 basic laws of hydraulics using a simulator apply rules of safety in the laboratory.

Specifications for Hydraulics in Machinist Technology

This is a ½ quarter course. The classes meet for 360 minute periods, 5 times a week. The total amount of time devoted to this instructional program is 30 hours per week, for 6 weeks or a total of 180 clock hours. This instructional program is part of a sequence of 6 courses and this is the 5th of the sequence.

Hydraulics in Machinist Technology is specifically designed to teach the student how to: use symbols and schematics in circuitry, use quick disconnects - pipes - hose - tubing on a simulator, build a mock-up reservoir, use a 2 and 3 position directional valves to direct the oil flow through 2-3-4-5 ports, control directional valves manually - mechanically hydraulically - electrically use open-closed and tandem-center directional valves, use gear, vane, and piston fixed and variable pumps on test panels, use "meter in" - "meter out" - "bleed off" flow control valves to control speed, control operating pressure with a pressure reducing valve, use a sequence valve to move 3 cylinders, use an unloading valve dump incidental to excess flow of oil to the reservoir, use a braking valve to control the speed of stoppage, use a valve to counterbalance the load to keep it from falling, use a cylinder to move a linear and rotary load, diagram - assemble - operate a complex hydraulic system or a simulator, apply rules of safety when using hydraulic components and simulators.

The method of teaching this class is through: lectures, films, demonstrations, use of instructional sheets, text book assignments for study and grading, objective tests, and diagram circuits, problems and projects assigned for use on a simulator.

Equipment available to teach this instructional program: 1 portable supply unit, 3 simulators, demonstration and test type, 2 valve and circuit boards, 1 working model circuit stand, 4 gear pumps, 3 valve pumps, 2 piston pumps, 10 directional valves, 10 flow control valves, 15 pressure control valves, 20 actuators, 1 manometer, miscellaneous gauges, hoses, fittings cut-aways and regulators.

TEACHING GUIDE FOR HYDRAULICS IN MACHINE TECHNOLOGY

I. Introduction to Machine Technology Hydraulics

1. Definition of fluid power
2. History of fluid power
    - A. Development
    - B. Rate of growth
    - C. Pioneers in fluid power
3. Applications
4. Potential
5. Advantages and disadvantages

II. Safety

1. Electrical hazards - with demonstration
2. High pressure hazards - with demonstration
3. Good housekeeping
4. Care of equipment
5. Fluids
6. Machine guards
7. Protective shields and clothing
8. Shop practices

III. Introduction to symbols

1. JIC and ASA
    - A. Description
    - B. Need for standardization
    - C. Symbols and definitions for symbols
        - a. reservoir
        - b. lines
        - c. pumps
        - d. relief valves
        - e. cylinders
        - f. strainers
2. Simple circuit symbols

IV. Fundamental laws and principles

1. Pascals law
2. Bernoulli's law
3. Boyles law
4. Charles' law
5. Gay-Lussac

V. Fluid power principles and formulas

1. Area
2. Force
3. Pressure

4. Volume
5. Velocity
6. Work
7. Power
8. Horse power
9. Input-output ratio

VI. Reservoirs

1. Purpose and function
2. Design and construction
3. Volume
4. Care and maintenance

VII. Hydraulic Fluids

1. Classifications
2. Types of fluid
3. Physical characteristics
   A. Viscosity
   B. Viscosity Index
   C. Pour point
   D. Flash point
4. Additives
5. Handling precautions

VIII. Conductors

1. Pipe
   A. Applications
   B. Determining size
      1. Wall thickness
   C. Thread standards
   D. Use of pipe tools
   E. Fittings
   F. Planning the circuit
2. Tubing
   A. Application
   B. Determing size
   C. Classifications
   D. Use of tubing tools
   E. Fittings
   F. Planning the circuit
3. Hose
   A. Applications
   B. Determining size
   C. Classifications
   D. Use of hose tools
   E. Fittings
   F. Planning the circuit

XIV. Fluid conditioners

1. Strainers
2. Filters

   3. Cleaning devices
   4. Filter selection
   5. Care and maintenance

X. Pumps

1. Introduction
2. Purpose
3. Classification
   - A. Positive displacement
      - 1. Constant delivery
   - B. Non-positive displacement
      - 1. Variable displacement
4. Types
   - A. Rotary
      - 1. Gear
      - 2. Vane
      - 3. Miscellaneous
   - B. Reciprocating
      - 1. Axial piston
      - 2. Radial piston
   - C. Two-stage
   - D. Double-pump
5. Pump operations
   - A. Gear pump
      - 1. Design and mechanics
      - 2. Variations
      - 3. Balanced
      - 4. Unbalanced
   - B. Vane pumps
      - 1. Design and mechanics
      - 2. Variation
   - C. Piston pumps
      - 1. Design and mechanics
      - 2. Variations
6. Relation to other components
   - A. Reservoirs
   - B. Relief valve
   - C. Prime mover
   - D. Fittings and piping
7. Application in circuits
   - A. Single
   - B. Series
   - C. Parallel

XI. Actuators

1. Actuator uses
   - A. Pushing
   - B. Pulling
   - C. Lifting
   - D. Lowering
   - E. Transferring
   - F. Clamping

2. Classifications
    - A. Aircraft
    - B. Telescoping
    - C. Farm and construction
    - D. Industrial
3. Types and design
    - A. Single acting
    - B. Double acting
    - C. Double rod end
    - D. Adjustable stroke
4. Mountings
    - A. Tie rod mounting
    - B. Flange mounting
    - C. Lug mounting
    - D. Pivot mounting

XII. Directional Valves

1. Introduction
    - A. Need
2. Simple valve
    - A. Globe
    - B. Gate
    - C. Needle
3. Classifications
    - A. Two-way
    - B. Three-way
    - C. Four-way
4. Position
    - A. Two-position
    - B. Three-position
5. Control
    - A. Manual
    - B. Mechanical
    - C. Solenoid
    - D. Pilot
    - E. Combination
6. Spring condition
    - A. No spring
    - B. Spring center
    - C. Spring off-set
7. Center condition
    - A. Open center
    - B. Closed center
    - C. Tandem center
8. JIC and ASA symbols
9. Draw circuits using symbols

XIII. Pressure Control Valves

1. Pressure relief valves
    - A. Definition
    - B. Purpose and need

2. Types
   A. Simple relief valve
      1. Ball
      2. Poppet
      3. Spool or plunger
   B. Relief valves (Hydraostatic balance)
      1. Advantages
      2. Design
      3. Operation
3. Flow control valves
   A. Definition
   B. Purpose and need
   C. Simple flow control valves
      1. Fixed orifice
         a. non-compensated
         b. check valve (with and without)
      2. Adjustable orifice
         a. non-compensated
         b. check-valve (with and without)
      3. Pressure compensated
         a. operation
         b. check valve (with and without)
      4. Temperature compensated
4. JIC and ASA symbols
5. Draw circuit using symbols
   A. Meter in
   B. Meter out
   C. Bleed off
6. Counter balance valve
   A. Purpose
   B. Need
   C. Directly operated
      1. Internally drained
   D. Remote operated
      1. Internally drained
7. Sequence valve
   A. Purpose
   B. Need
   C. Directly operated
      1. Internally drained
   D. Remote operated
      1. Internally drained
8. Unloading valve
   A. Need
   B. Operation
   C. Remote Control
      1. Internally drained
9. Brake valve
   A. Need and application
   B. Operation
10. Servo-valve
   A. Application
   B. Advantages
   C. Operation
      1. Electronic components
      2. Hydraulic components

Audio-Visual Equipment

Projection Screen
Tape recorder and player combination To be used with slide projector
Overhead projector
Slide projector (carousel) manual - automatic
DuKane Projector
16 mm Projector
Transparencies
2 x 2 slides
Strip films
16 mm films

Suggested Classroom Equipment

Lecture table
Classroom tables
Classroom chairs
Chalkboard 4' x 12'
Component and cut-a-way racks
Storage cabinet
Pamphlet and publication rack
Pencil sharpener
Bulletin Board
Waste paper baskets

Suggested Library Equipment

Book shelves
Pamphlet and publication rack
Study table
Chairs
Waste paper basket

Supplies

Wiping rage
Hydraulic oil
Ditto or mimeograph student guides
Symbol templates
Colored chalk
Colored pencils

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Fire Resistant Fluids. E.F. Houghton Company, Philadelphia, Pa.

Fluids and Seals. The Dynex Company, Pewaukee, Wisconsin

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Tube Fitters Manual: Bulletin 4326 B2. Parker-Hannifin Corporation, Cleveland, Ohio.

Use ful Oil Hydraulic Fluid Power Glossary of Terms - Design Data: Bulletin 100p41. Commercial Shearing and Stamping Company, Youngstown, Ohio.

FLUIDICS TERMINOLOGY

ACTIVE	A fluidic device which is directly attached to the power supply.
AMBIENT	The broad term covering environmental conditions around the area of the device, i.e.--that is atmospheric pressure or temperature or both.
ANALOG	The general class of fluidic elements or circuits having proportional characteristics.
AND	Basic logic device which has an output when all control signals are on.
BEAM DEFLECTOR	A proportional fluidic device which uses control pressure and/or flow to deflect a fluid jet or beam for the functional operating principle.
BI-STABLE	A fluidic device having two separate and distinct output such as "off and on" or "high and low" etc.
CIRCUITS	Arrays of inter-connected fluidic elements which performs specialized functions or standard functions.
DIGITAL	The general class of fluidics or circuits which have "on-off" characteristics.
DIGITAL AMPLIFIER	A digital element which provides amplification and has negigible hysteresis (i.e. no memory), therefore a continual input signal is required to maintain a given state bi-stable.
DIODE	A fluidic element which has higher resistance to flow in one direction compared to that in the opposite direction (a check valve)
DIVERTING	A type of control where the flow is continuous and the normal output of the device is turned off by diverting the flow to another unused port.
ELEMENTS	Fluidic devices and/or logic devices which are inter-connected to form working circuits. Also the general class of devices used in conjunction with fluidic devices in circuits such as fluid restrictors and capacitors.
ENCLOSED PROPORTIONAL AMPLIFIER	Is a closed fluidic device which has no communication with the local ambient.

FANOUT	The number of elements which can be driven by a single element. All elements to be operated at the same supply pressure. Also elements to be of similar size and to have similar switch points.
FLIP-FLOP	A digital fluidic element which has a hysteresis loop of sufficient width so that it has "memory". Its state is changed with an input pulse; a continual input signal is not necessary for it to exhibit by stability.
FLOW AMPLIFIER	An element designed specifically for amplifying flow signals.
FLUIDICS	The general field of fluid no-moving-parts control and related logic devices.
FLUIDIC CAPACITOR	A fluidic element which produces a pressure drop as a function of the flow through it.
FLUIDIC VALVE	A fluidic device which has the end use of diverting or modulating flow.
HYSTERESIS	The total width of hysteresis loop expressed as a percent of peak-to-peak saturation input signal. Measurement to be at frequencies below those where dynamic effects become significant.
INCHES OF WATER	A term used to define very low pressures, relating to reading the low pressures on a water column manometer. (27.7" H_2O = 1 P.S.I.G.)
INVERTER	A basic device relating to NOT logic which has an output contrary to its single input signal.
ISOLATION	The characteristic of a fluidic device having more than one control port where the control signal at one of the control ports in no way effects any of the other control ports. Also having to do with the prevention of the control pressure at one port working back to some other portion of the logic circuit.
LAMINAR	A type of flow of a liquid or a gas wherein the fluid moves in parallel layers--the velocities of these layers not necessarily being the same.
LOGIC	The science of correct reasoning; science which deals with the criteria of valid thought.

LOGIC ELEMENTS	The general category of fluidic devices which provide logic functions such as AND, OR, and NOR, They can gate (stop or inhibit) signal transmission with the application, removal, or other combination of input signals.
MODULATING	A modulating flow device is one which is capable of varying the flow output, but to never completely shut the flow off.
NOR	A basic logic device which has an output when all control inputs are off.
NOT	A basic logic device which has an output signal when the single input signal is "off" and has no output when the signal is "on".
OR	A basic logic device which has an output if any of its multiple controls have an input.
PASSIVE	A fluidic device which operated on input power derived from the output of another fluidic device.
POWER AMPLIFIER	An element optimized to provide maximum power gain. That is the product of pressure and flow.
PRESSURE AMPLIFIER	An element designed specifically for amplifying pressure signals.
PROPORTIONAL	The general class of fluidic elements or circuits having analoging characteristics, i.e. that is output is proporational to input.
RESPONSE TIME	The time delay between the application of an input step signal and the resulting output step signal. (The time measurements for the step signals are to be made at the 50% of final value point.)
SENSOR	A fluidic element which in general senses quantities or media other than those related to fluids and converts them into fluid quantities.
TRANSDUCER	A device which converts signals in other than fluid media into fluid signals (i.e. pressure switch which converts a pneumatic signal into an electrical signal, or a solenoid valve which converts an electrical signal into a pneumatic signal).

TURBULENCE AMPLIFIER	A fluidic digital element which uses for the basic operating principle the Laminar to turbulent transition of a jet controlled by input signal flow.
TURBULENT	A type of flow wherein the velocity at any point may vary both in magnitude and in direction--a "mixed up" type of flow.
VENTED PROPORTIONAL AMPLIFIER	An open fluidic amplifier utilizing vents to extablish the ambient pressure in the interaction region.
VORTEX	A fluidic device which utilized the pressure drop across a Vortex for the modulating principle (Whirlpool type)
WALL ATTACHMENT DEVICES	Fluidic devices which use jet attachment to a wall (Coanda effect) for the basic operating principle.

Galland-Henning Mfg. Co.
Milwaukee, Wisconsin 53246

16 mm Films

1.	"Application of Pascals Law, Part I	15 min/16 mm Color sd.	United World Films Gov't Film Dept. 1445 Park Avenue New York 29, N.Y.
2.	"Application of Pascal's Law, Part II	15 min/16 mm Color sd	United World Films Gov't Film Dept. 1445 Park Avenue New York 29, N.Y.
3.	"Basic Hydraulics"	15 min/16 mm Color sd	United World Films Gov't Film Dept. 1445 Park Avenue New York 29, N.Y.
4.	"Fluid Flow in Hydraulic System"	15 min/16 mm Color sd	United World Films Gov't Film Dept. 1445 Park Avenue New York 29, N.Y.
5.	"Basic Principles of Hydraulics"	16 mm sd	Jam Handy Organization 2821 S. Grand Blvd. Detroit 3, Michigan
6.	"Characteristics of Hydraulic Fluids"	20 min/16 mm Color sd	Civil Aeronautics Administration
7.	"Controlled Power"	25 min/16 mm Color sd	Vickers, Inc. P.O. Box 32 Detroit, Michigan
8.	"Design for Power"	18 min/ 16mm Color sd	Denison Hydraulic Division
9.	"Four Experiements in Hydraulics"	17 min/16 mm Color sd	National Bureau of Standards Office of Scientific Publication Washington, D.C.
10.	"Harnessing Liquids"	12 min/16 mm	Shell Oil Company
11.	"Hydraulic Oils"		Texas Company
12.	"Hidden Giant"		Vickers, Inc. P.O. Box 32 Detroit, Michigan
13.	"Types and Qualities of Oils"		Texas Company
14.	"Axial Piston Pumps"		U.S. Navy Bureau of Aeronautics

15. "Cauitation" Shell Research Limited

16. "Rando Oil Hd." Texaco

Slides

"Basic Automation" 25 2" x 2" Sildes, Double A Products Co., Manchester, Michigan.

"Directional Control Valves" 20 2 x 2 Slides, Double A Products Co., Manchester, Michigan.

"Fluid Power Components and Circuit Series" (Slide Series) Kenosha Technical Institute.

"Fluid Power: The Muscles and Nerves of Modern Industry" 30 2 x 2 Slides, Modernaire Corporation, San Leandro, California

"Press Circuits" 9 2 x 2 Slides, Double A Products Co., Manchester, Michigan.

"Pumps and Motors" (Slide Series) Double A Products Co., Manchester Michigan.

"Industrial Fluid Power" 36 2 x 2 Slides on each of the six chapters, Total of 216 2 x 2 Slides. Womack Machine Supply Co. 2010 Shea Road, Dallas, Texas.

"Pressure Control Valves" 12 2 x 2 Slides. Double A Products. Co. Manchester, Michigan.

Film Strips

"Cylinder Selection and Application Considerations" (Film Strip) Parker-Hannifin Corporation. Cleveland, Ohio.

"Elements of Hydraulics" (Film Strip) Parker-Hannifin Corporation, Cleveland, Ohio.

"Hydraulic Fittings" (Film Strip) Parker-Hannifin Corporation. Cleveland, Ohio.

"Hydraulic Components" Color Slide Films. Denisón Engineering 1236 Dublin Road, Columbus, Ohio.

Suggested Tool List. . . . . Student Issue

Tool Box			
Feeler Gauge Set	.0015 - .035		
Ball Pien Hammer	14 oz.		
Soft face hammer	12 - 16 oz.		
Combination pliers			
Diagonal pliers			
Water pump pliers			
Long nose pliers			
Box end wrench set	3/8" - 1"		
Open end wrench set	3/8" - 7/8"		
Socket set	3/8" - 7/8"	3/8" drive	7/16 - 1" drive
Ratchet	3/8 drive		
Breaker Handle	½" drive		
Speed Handle	3/8" drive		
Chisels	¼ - ½ point		
Punches	1/8" pin punch	¼" drift punct	
Brass punches			
Allen wrench set			
Gasket scrapers			
Screw drivers	Phillips and Common		

The number of students tool kits will depend upon the number of students in the class. One tool kit for each work station may be sufficient.

Suggested Shop Tools

Combination wrenches	1" - 2¼"
Torque wrenches	Inch - oz. Foot pound inch pound
Adjustable wrenches	12" - 18"
Pipe wrenches	8" - 12" - 16"
Hex head socket set	
Spanner wrench	
Tubing cutter and flaring set	45° and 37°
Tubing benders	
Gear puller set	
Oil cans	
Oil measure cans	
Barrel pump	
Miscellaneous hydraulic and air hoses	
Quick couplers	
Pipe tap and die set	1/8" - 1¼"
Sae tap and die set	
Screw and tap extractor	
Thread chases	
¼" pneumatic portable drill	
½" pneumatic portable drill	
Drill bits - Number, Fractional, Letter	
Adjustable reamers	
Miscellaneous files	flat, 3 square square
Hack saws	
Thread gauges	
Outside micrometers	.000" - 6.000"
Depth micrometer set	.000" - 4.000"
Inside ball gauges	.125 - .500
Inside telescope gauges	.000" - 4.000"
Dial Gauge	.250" travel

Suggested Shop Equipment

Hydraulic hoist
Hydraulic press
Hand press
Air compressor
Bench grinder
Oxy-Acet welder
Arc welder (rectifier)
Hydraulic hose crimping tool
Parts washer
Spring tension tester
½" pneumatic drill press
Rag barrels
Fire extinguishers
Trash barrels

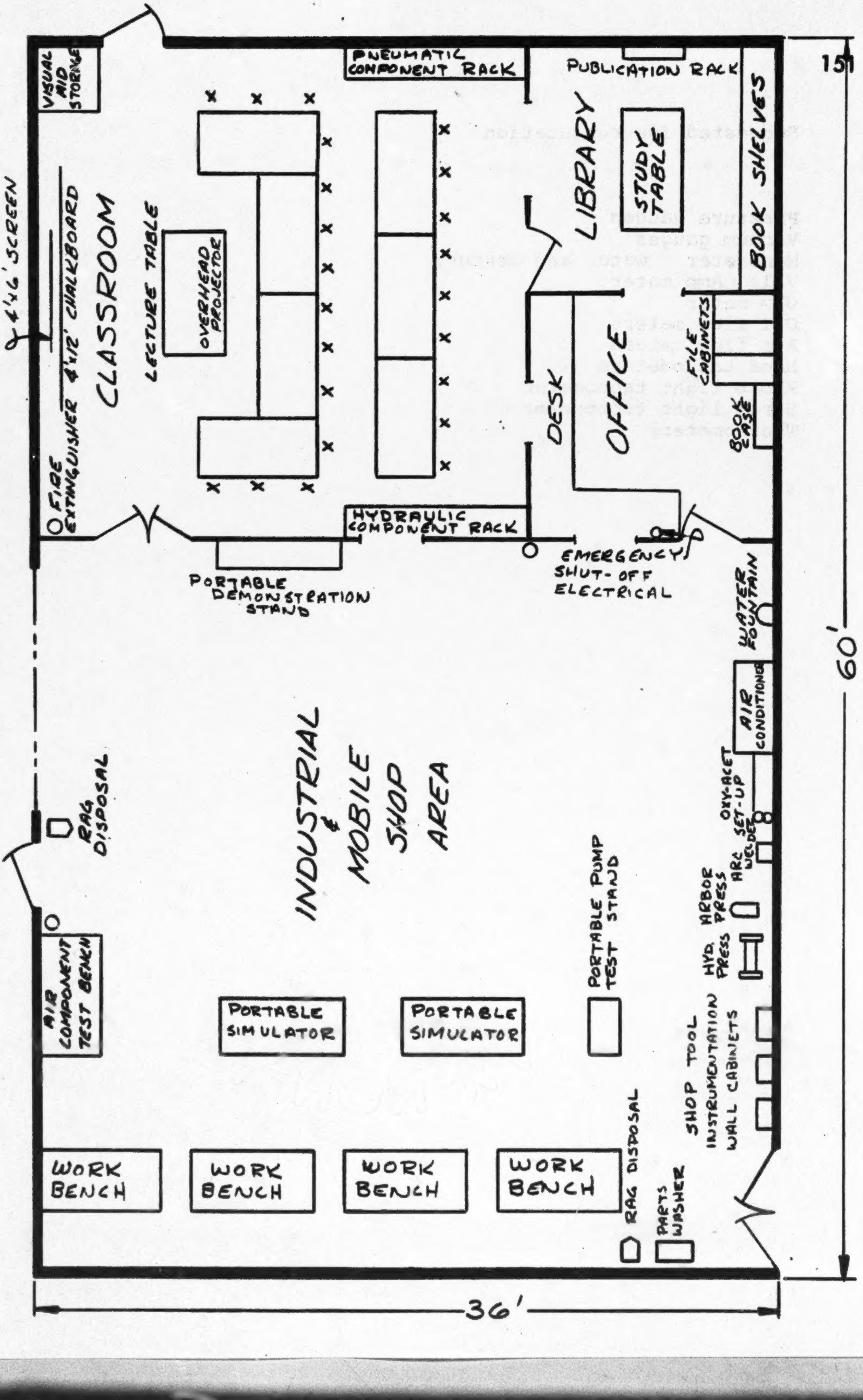
Suggested Instructional Equipment

Portable power supply unit
Simulators Demonstration and test type
Valve and circuit boards
Working model circuit stands
Pumps Vane, Gear, Piston, Miscellaneous
Conductors hoses, lines, fittings, quick couplers, Air and Oil
Valves pressure control, directional, flow control, sequence counter balance, servo
Actuators Single acting, couple acting, cushioning piston and vane motors.

The quantity of each component will depend upon the number of students in the class.

Suggested Instrumentation

Pressure gauges
Vacuum gauges
Manometer water and mercury
Volt Amp meter
Ohm meter
Oil flow meters
Air flow meters
Hand tachometers
Photo light tachometer
Strob light tachometer
Thermometers


VISUAL AID STORAGE
4'x6' SCREEN
4'x12' CHALKBOARD
CLASSROOM
LECTURE TABLE
OVERHEAD PROJECTOR
FIRE EXTINGUISHER
PNEUMATIC COMPONENT RACK
PUBLICATION RACK
LIBRARY
STUDY TABLE
BOOK SHELVES
DESK
OFFICE
FILE CABINETS
BOOK CASE
HYDRAULIC COMPONENT RACK
PORTABLE DEMONSTRATION STAND
EMERGENCY SHUT-OFF ELECTRICAL
WATER FOUNTAIN
AIR CONDITIONG
OXY-ACET SET-UP
ARC WELDER
ARBOR PRESS
HYD. PRESS
INDUSTRIAL & MOBILE SHOP AREA
RAG DISPOSAL
PORTABLE PUMP TEST STAND
AIR COMPONENT TEST BENCH
PORTABLE SIMULATOR
PORTABLE SIMULATOR
SHOP TOOL INSTRUMENTATION WALL CABINETS
WORK BENCH
WORK BENCH
WORK BENCH
WORK BENCH
RAG DISPOSAL
PARTS WASHER
60'
36'

WAYNE STATE UNIVERSITY
DEPARTMENT OF INDUSTRIAL EDUCATION

SUGGESTED PROGRAM IN FLUID POWER FOR TEACHER EDUCATION: ASSOCIATED DEGREE IN MECHANICAL ENGINEERING TECHNOLOGY

Prepared by:

Robert W. Curtis
George B. Simoneau

July, 1966

INTRODUCTION

During the summer quarter of 1966, a Fluid Power Institute seminar was held at Wayne State University as a part of the instructional program. Participants were required to evaluate available materials and develop an instructional program which could be used of their institution. This project was to include: a course outline, selection of a textbook, list of references, list of audio-visual materials, evaluation instrument for the selection of equipment, a list of tools and a laboratory layout.

Participants teaching of the community college level prepared these materials to be road tested in a mechanical engineering technology program with the aim of meeting ECPD requirements.

It should be remembered that this was an initial effort and written by experienced teachers during an intensive program of instruction in fluid power. It is therefore, a proposed introductory course and not a curriculum. As such, it is the first step in organizing an instructional program geared to a specific level of instruction, in this case for a program leading to a 2-year associate degree in mechanical engineering technology.

It was the major objective of the seminar to structure a framework for the instructional program in fluid power so it would be practicable to a specific level. This early attempt by the two authors, is to serve as a springboard for further development of curriculum materials in fluid power technology.

William Wolansky
Instructor

PREFACE

This Fluid Power course outline is intended for use in an ECPD accredited curriculum leading to an associate Degree in Mechanical Engineering Technology.

Consisting of sixty hours, it presents only basic fundamentals and typical applications. As such, it is an introductory experiences in fluid power as will enable him to profit from in-service and plant training programs.

DESCRIPTION OF COURSE

Course Objectives

General

1. To stimulate student interest in Fluid Power.
2. To provide industry with Associate Degree graduates who can assist engineers in the design, development and testing of components, sub-systems and/or systems involving Fluid Power.

Specific

1. To acquaint students with the role of hydraulics in industry.
2. To acquaint students with job opportunities in Industrial Hydraulics.
3. To discuss fundamental principles such that the student can solve problems involving Potential Energy, Kinetic Energy Force, Pressure and Area Relationships, Pascal's Law, Boyle's Law, Bernoulli's Principle, and Horsepower.
4. To acquaint students with theory and practices related to the generation, transmission, control, utilization and application of Fluid Power.
5. To briefly introduce Pneumatics
6. To briefly introduce Fluidics

General Description

The Fluid Power Course outline can be taught anytime during the second year of the Associate Degree Mechanical Engineering Technology Curriculum, and is a requirement for graduation. It is a twelve-week program having three lecture hours and two laboratory hours per week. Credit value is three hours for lecture and one hour for laboratory.

The laboratory program is not outlined because it is a function of equipment and facilities available. Each laboratory program must be tailored accordingly. Three recommendations:

1. A Fluid Power Laboratory should have one hydraulic demonstration stand as a minimum requirement
2. Industrial fluid power components should be available for instructional purposes-disassembly and reassembly.
3. Two or three plant tours should be made so that students can see Fluid Power in action.

Technical prerequisites are college level Algebra, Trigonometry, and Physics. A primary non-technical prerequisite is Communications, especially Report Writing. Co-requisites are

Electricity (DC and AC) and Instrumentation, the minimum of which should be mechanical transducers. These courses are essential to effecting a complete understanding of Fluid Power.

COURSE OUTLINE - INDUSTRIAL HYDRAULICS

I. Orientation

- A. Introduction
- B. Class requirements
- C. Course outline review

II. Industrial Hydraulics

- A. Historical Development
    - 1. Pre-World War II
    - 2. Post-World War II
- B. Reasons for use
    - 1. Advantages
    - 2. Limitations
- C. Typical Industrial Applications
    - 1. Parts fabrication
        - a. Extrusion presses
        - b. Machine tools
        - c. Rolling mills
        - d. Coolant distribution and reclamation
    - 2. Automation
        - a. Parts transfer
        - b. Tool machine indexing
        - c. Parts handling
        - d. Assembly
        - e. Inspection
- D. Typical Vehicle Uses
    - 1. Automotive
        - a. Cooling systems
        - b. Power brakes
        - c. Power steering
        - d. Fuel systems
    - 2. Aero-Space
        - a. Flight controls
        - b. Landing gear
        - c. Missile launching
        - d. Space flight
    - 3. Building Construction - Earth Moving
        - a. Back-hoe
        - b. Bulldozers
        - c. Cranes
        - d. Dump trucks
        - e. Fork lifts
        - f. Tractors
    - 4. Other
        - a. Agriculture
        - b. Chemical
        - c. Marine
        - d. Mining
        - e. Packaging
        - f. Petroleum
        - g. Railways
        - h. Utilities

III. Safety

- A. Hazards
  - 1. Electrical
  - 2. Pressure
  - 3. Flammable fluids
  - 4. Clothing
- B. Safe Practices

IV. Fundamentals

- A. Newton's Laws
  - 1. Definition
  - 2. Energy
    - a. Potential
    - b. Kinetic
- B. Definitions
  - 1. Force, area, pressure, head and volume
  - 2. Work, power, and horsepower
  - 3. Mass density and weight density
- C. Liquids at rest
  - 1. Pascal's Law
    - a. Definition
    - b. Applications
- D. Liquids in motion
  - 1. Definition
    - a. Volume and velocity of flow
    - b. Steady and unsteady flow
    - c. Laminar and turbulent flow
  - 2. Factors involved
    - a. Static
    - b. Dynamic
    - c. Force, pressure and head relations
    - d. Measurement
  - 3. Bernoulli's equation
    - a. Derivation
    - b. Application

V. Simplified Hydraulic Symbols

- A. Need
- B. JIC,ASA and ISO
  - 1. Present
  - 2. Proposed
- C. Discussion
  - 1. Transmission (plumbing)
  - 2. Generation (pumps)
  - 3. Control (valves)
  - 4. Application (circuits)
  - 5. Composites
- D. Diagrams
  - 1. Graphical
  - 2. Circuit
  - 3. Cutaway
  - 4. Pictorial
  - 5. Combination

HOUR TEST AND ½ HOUR REVIEW

VI. Hydraulic fluids

- A. Classifications
    - 1. Petroleum base
    - 2. Fire resistant
- B. Chemical and Physical Characteristics
    - 1. Viscosity
    - 2. Viscosity index
    - 3. Pour-point
    - 4. Flash-point
    - 5. Chemical stability
    - 6. Acidity
    - 7. Lubricity
    - 8. Oxidation resistance
    - 9. Water separating ability
    - 10. Antirust properties
    - 11. Foaming resistance
    - 12. Additives
- C. Selection factors
    - 1. Speed of operation
    - 2. Ambient environment conditions
    - 3. Economic conditions
    - 4. Pressure level
    - 5. Safety to operators
    - 6. Other

VII. Reservoirs

- A. Purpose
- B. Types
    - 1. Cavity
    - 2. Structural pipes
    - 3. Combination, lubrication and hydraulic
    - 4. Rectangular or square
    - 5. L-Shaped
    - 6. Scavenger
    - 7. Settling
- C. Sizing
- D. Construction

VIII. Pumps (Power Generation)

- A. General
    - 1. Purpose
    - 2. Types
        - a. Positive displacement (transmit power)
        - b. Non-positive displacement (transfer fluid)
    - 3. Performance
        - a. Slippage
        - b. Horsepower
        - c. Efficiency
        - d. HQ and PQ curves
- B. Positive Displacement
    - 1. General
        - a. Fixed (constant) displacement
        - b. Variable displacement
    - 2. Principles of Operation
        - a. Gear
        - b. Vane and intra-vane
        - c. Piston
    - 3. Variations
        - a. 2-stage
        - b. Double
        - c. Combination

- C. Non-positive Displacement
  - 1. General
    - a. Centrifugal
    - b. Propeller
    - c. Mixed flow
  - 2. Principles of Operation
    - a. Impeller
    - b. Diffuser
    - c. Peripheral
    - d. Propeller
    - e. Mixed flow
- D. Jet Pump
- E. Other
  - 1. Head relations
  - 2. Maintenance

MID TERM EXAM - 1.5 HOURS
1 hour test
½ hour review

IX. Plumbing (Fluid and Power Transmission

- A. Purpose
- B. Classification
  - 1. Pipe
  - 2. Tubing
  - 3. Hose
  - 4. Fittings and Connectors
- C. Practices and techniques
  - 1. Selection
  - 2. Installation
  - 3. Maintenance

X. Filtration

- A. Purpose
- B. Principle
- C. Type
- D. Cautions

XI. Valves (Control)

- A. General
  - 1. Function
  - 2. Types
    - a. Flow control
    - b. Pressure control
    - c. Directional control
- B. Flow control
  - 1. Basic types
    - a. Cock
    - b. Gate
    - c. Globe
      - (1. Disc
      - (2. Needle
    - d. Check

2. Non-adjustable compensated
3. Adjustable, compensated

C. Pressure Control
  1. Relief valves
    a. Simple
    b. Compound
  2. Pressure-reducing
  3. Sequence
  4. Unloading
  5. Counterbalance
  6. Brake
  7. Pressure-dividing
  8. Pressure switches

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1 HOUR EXAM AND ½ HOUR REVIEW

D. Directional Control
  1. Types
    a. Spool
    b. Rotary
  2. Two-way
  3. Three-way
  4. Four-way
  5. Five-way
  6. Controls
  7. Servo-valves

XII. Cylinders, Rotary Motors (Utilization of Hydraulic Power)

A. Cylinders
  1. Common
    a. Single-acting
    b. Double-acting, single-rod
    c. Double-acting, double-rod
    d. Telescoping
  2. Rams
B. Rotary Motors

XIII. Accessories

A. Description and use
  1. Accumulators
  2. Heat exchangers
  3. Intensifiers
  4. Electric controls

XIV. Circuit Applications

A. Description and Use
  1. Simple circuit
  2. Meter-in
  3. Meter-out
  4. Bleed-off
  5. Reduced pressure
  6. Counterbalance
  7. Sequence
  8. Unloading
  9. Braking
  10. Other

XV. Pneumatics

- A. Comparison with Hydraulics
  - 1. Likenesses
  - 2. Differences
  - 3. Advantages
  - 4. Disadvantages
- B. Components
- C. Uses

XVI. Fluidics

- A. Definition
- B. Uses

FINAL EXAM 2 HOURS

RESOURCE MATERIALS

A. References

1. Books
   - a. Oil Hydraulic Power and its Industrial Applications, Walter Ernst. McGraw-Hill Publishing Company. 2nd Ed., 1960. $12.50
   - b. Fluid Power Controls, Pippinger and Koff, McGraw-Hill.
   - c. Basic Hydraulics, NAVPERS 16193, Superintendent of Documents, U.S. Government Printing Office. Washington, D.C. 1952. $1.75
   - d. Compressed Air Handbook, Compressed Air and Gas Institute.
   - e. Fluid Power Book, Machine Design Magazine, Penton Publishing Company, Cleveland, Ohio 44113.
   - f. Fluid Power Handbook and Directory, Industrial Publishing Group, 812 Huron Road, Cleveland 15, Ohio. $12.00
   - g. Fundamentals of Pneumatic Control, St. Regis Paper Company, East Providence, R.I.
   - h. Glossary of Terms for Fluid Power, National Fluid Power Association, Box 49, Thiensville, Wisconsin.
   - i. Hydraulic Handbook,Trade and Technical Press, Ltd. London, England.
   - j. Operation and Care of Hydraulic Machinery, The Texas Company. New York, N.Y. Free.
   - k. Principles of Hydraulics, Trade and Technical Press, Ltd. London, England.
   - l. Useful Oil Hydraulic Fluid Power Design Data, Commercial Shearing and Stamping Company, Youngstown 1, Ohio.
   - m. Simplified Hydraulics, L.S. McNickle, Jr. McGraw Hill. $10.00
   - n. Industrial Fluid Power Text, Charles Hedges, Womach Machine Supply Co., 2010 Shea Road, Dallas Texas 75235 $5.75.
   - o. Fluid Mechanics and Hydraulics, Ronald Giles, Schaum Publishing Company, New York, N.Y. $3.50
   - p. Practical Hydraulics, George Altland, Vickers Incorporated. P.O. Box 302, Troy, Michigan Free.
   - q. Pneumatic Power, Lab Manual, Vega Enterprises Box 1006, Decatur, Illinois $3.00
   - r. Hydraulic Power, Lab Manual. Vega Enterprises Box 1006, Decatur, Illinois $3.00
   - s. Hydraulic Controls on Machine Tools, Frank Mackin, General Motors Institute, Flint Michigan
   - t. Industrial Hydraulics, Pippinger and Hicks, McGraw Hill Company, New York, N.Y.
   - u. Hydraulic System for Industrial Machines, Socony Mobil Oil Co., New York, N.Y. 1966, Free
   - v. Hydraulic Circuit Selector Handbook, Bellows-Valvair, Akron, Ohio 1965, Free.

w. Hydraulic Power Transmission, Engineers Bulletin, No. HP - 221, American Oil Company, 910 S. Michigan Avenue, Chicago, Illinois, Free

x. Audels Practical Guide to Fluid Power, Harry L. Stewart, Theodore Audel and Company. A division of Howard W. Sams and Co., Indianapolis, Indiana First Edition 1966 - $6.95

y. Fluid Power, An outline prepared by participants in the 1964 Wayne State University Institute. Available from Fluid Power Society, Box 49, Thiensville, Wisconsin, Free.

z. Hydraulics, George E. Russell, Henry Holt and Company, Inc. New York, N.Y.

2. Periodicals

a. Hydraulics and Pneumatics Magazine, Industrial Publishing Company, 812 Huron Road, Cleveland Ohio.

b. Fluid Power International, John Trundell, Eversholt Street, London N.W. 1., England.

c. Machine Design Magazine, Penton Publishing Co., Penton Building, Cleveland, Ohio.

d. Product Engineering, 330 N. 42nd Street. New York, N.Y. 10036.

e. Compressed Air, 942 Memorial Parkway, Phillipsburg N.J. 08865.

B. Films and Filmstrips

1. Films (16mm)

a. Hydraulic Oils
Texaco, Inc.
135 East 42nd Street
New York 17, N.Y.

b. The Hidden Giant
Vickers, Inc.
Administration and Engineering Center
P.O. Box 302
Detroit, Michigan 48084

c. Controlled Power
Vickers, Inc.
Administration and Engineering Center
P.O. Box 302
Detroit, Michigan 48084

d. Cavitation
Shell Oil Company

e. Harnessing Liquids
Shell Oil Company

f. Basic Hydraulics
Ford Motor Company
Training Division
Dearborn, Michigan

g. Fluid Flow
Ford Motor Company
Training Division
Dearborn, Michigan

h. Hydraulic Turret Traversing Mechanism
The Oilgear Company
1560 W. Pierce Street
Milwaukee 4, Wisconsin

i. Operation Pushbutton
Bellows Valvair
Att: Sales Manager
222 W. Market Street
Akron, Ohio

j. Denison Vane Pumps
Denison Hydraulics Division
Attn: Advertising Manager
1236 Dublin Road
Columbus, Ohio

k. Design for Power
Denison Hydraulics Division
Attn: Advertising Manager
1236 Dublin Road
Columbus, Ohio

l. Hydraulic Components
Denison Hydraulics Division
Attn: Advertising Manager
1236 Dublin Road
Columbus, Ohio

m. Power Up
Denison Hydraulics Division
Attn: Advertising Manager
1236 Dublin Road
Columbus, Ohio

n. Our Industrial Air Power
Quincy Compressor Company
Quincy, Illinois

o. Basic Hydraulics
United World Films
Government Films Department
1445 Park Avenue
New York, N.Y.

p. Basic Principles of Hydraulics
Jam Handy Organization
2821 S. Grand Blvd.
Detroit 12, Michigan

2. Filmstrips (35 mm)

a. Elements of Compressed Air
Parker-Hannifin Corp.
Cleveland, Ohio

b. Elements of Hydraulics
Parker-Hannifin Corp.
Cleveland, Ohio

c. Hydraulic Fittings
Parker-Hannifin Corp.
Cleveland, Ohio

d. Pneumatic Circuitry
Parker-Hannifin Corp.
Cleveland, Ohio

e. Pneumatic Circuitry
   Parker-Hannifin Corp.
   Cleveland, Ohio

f. Introduction to Fluid Power
   Miller Fluid Power Company

g. Cylinders
   Miller Fluid Power Company

h. Air Valves and Pneumatic Systems
   Miller Fluid Power Company

i. Air-Oil Systems
   Miller Fluid Power Company

j. Air-Oil Boosters
   Miller Fluid Power Company

C. Transparencies

1. Three sets, of good quality, are available from Vega Enterprises, Route 3, Box 300B, Decatur, Illinois, as follows:

   No. SH, 24 sheets - $70.00
   No SHK, 11 sheets - $32.00
   No. SP, 17 sheets - $44.00

2. Transparencies can be produced locally using diagrams available from Vickers, Ford Motor Co, etc. Thermo-fax and Ozalid type machines can be used.

D. Programmed Instruction

The Flick Reedy Filmstrips (from Miller Fluid Power) are programmed instruction materials. At the present time they are being used on a trial basis by company representatives and are not available. It is expected that shortly, the company will have a supply of these available for use by educational institutions.

E. Additional References

1. Industrial Hydraulics Manual 935100, Vickers Machinery Hydraulic Division 1965.
2. Pump Selection and Application, Hicks 1957 McGraw Hill
3. Hydraulic Operation and Control of Machines, McNeil Ronald Press 1955.
4. Industrial Instrumentation Fundamentals, Fribance McGraw Hill, 1962.

LABORATORY EQUIPMENT

A. Evaluation of Simulators

Simulators, if properly chosen, can be a great help in teaching fluid power for the first time. After experience is gained in teaching fluid power, components can be acquired to build test stands to supplement the simulators. Cutaways should be made locally to explain the operation of various components such as valves, pumps, cylinders, etc. A number of components should be available for disassembly and assembly by the students. Simulators are presently available from:

Scott Engineering Sciences, Corp.
1400 S.W. 8th Street
Pompano Beach, Florida 33060

Vickers, Inc.
P.O. Box 302
Detroit, Michigan 48084

Vega Enterprises
Box 1006
Decatur, Illinois

Capitol Engineering Company
2020 West 78th Street
Minneapolis 23, Minn.

Electromatic Manufacturing Co., Inc.
McMinnville, Tennesee

Technical Education and Manufacturing, Inc.
542 Hilton Road
Ferndale, Michigan 48220

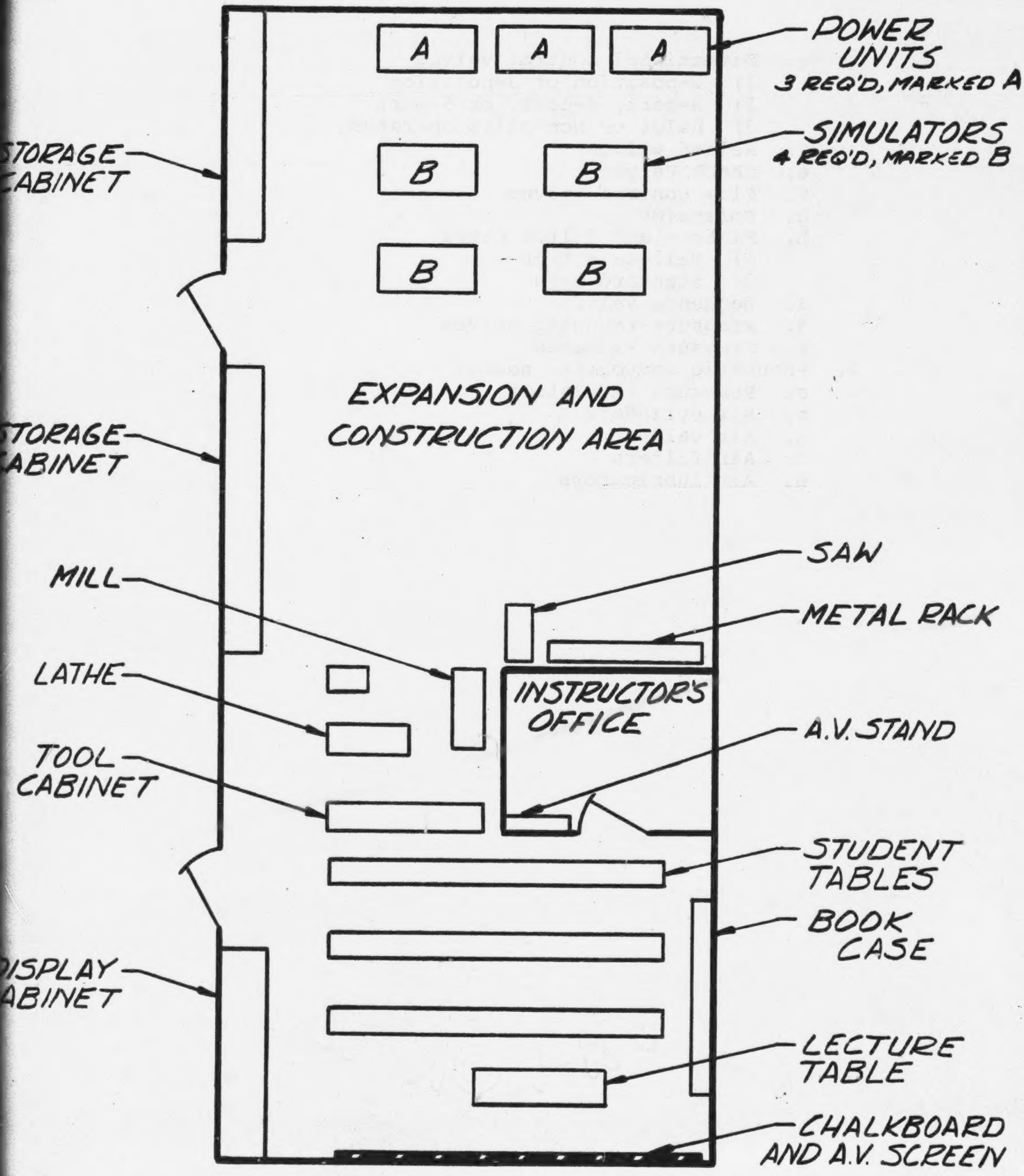
Information on all of the above simulators should be obtained and studied before a decision is made regarding which is suitable for a particular program. The prices of simulators range from $1,000 to $10,000.

B. Components Needed for Cutaways and/or Disassembly

1. Hydraulic Components Needed
    a. Pumps and/or motors
        1) Spur gear (or any gear type)
        2) Vane (balanced or unbalanced)
        3) Piston (radical or axial - fixed or variable displacement)
        4) Impeller (centrifugal)
    b. Cylinders
        1) Single or Double rod
        2) Cushioned or Non-cushioned

-- 5

   - c. Directional control valves
     - 1) 2-position or 3-position
     - 2) 3-port, 4-port, or 5-port
     - 3) Pilot or Non-pilot operated
   - d. Relief valves
   - e. Check Valves
   - f. Flow control valves
   - g. Solenoids
   - h. Filters and filter cases
     - 1) Tell-tale type
     - 2) Standard type
   - i. Sequence valves
   - j. Pressure-reducing valves
   - k. Pressure switches
- 2. Pneumatic components needed
   - a. Pressure regulators
   - b. Air cylinders
   - c. Air valves
   - d. Air filters
   - e. Air lubricators


POWER UNITS
3 REQ'D, MARKED A
A
A
A
STORAGE CABINET
SIMULATORS
4 REQ'D, MARKED B
B
B
B
B
STORAGE ABINET
EXPANSION AND CONSTRUCTION AREA
SAW
MILL
METAL RACK
LATHE
INSTRUCTOR'S OFFICE
A.V. STAND
TOOL CABINET
STUDENT TABLES
BOOK CASE
ISPLAY ABINET
LECTURE TABLE
CHALKBOARD AND A.V. SCREEN

FLUID POWER LABORATORY

JULY 27, 1966 SCALE $\frac{1}{8}$" = 1'

WAYNE STATE UNIVERSITY
DEPARTMENT OF INDUSTRIAL EDUCATION

SUGGESTED PROGRAM IN FLUID POWER FOR TEACHER EDUCATION: INTRODUCTORY COURSE

Prepared by:

John Butala, Jr.
Carroll C. Burkholder
Richard H. Carter
F. Theodore Paige

July, 1966

INTRODUCTION

During the summer quarter of 1966, a Fluid Power Institute seminar was held at Wayne State University as a part of the instructional program. Participants were required to evaluate available materials and develop an instructional program which could be used at their institution. This project was to include: a course of study, selection of a textbook, list of references, list of audio visual materials, evaluation instrument for the selection of equipment, a list of tools, and a laboratory layout.

Participants teaching at the college level including industrial technology and industrial education worked as a group to prepare this report.

It should be remembered that this was an initial effort and written during an intensive program of instruction in fluid power technology. It is therefore, a proposed introductory course and not a curriculum. As such, it is the first step in organizing an instructional program geared to a specific level of instruction, in this case for teacher education. This was essentially the major objective of the seminar. It is to be the springboard for further development of curriculum materials in fluid power technology.

William Wolansky
Instructor

PREFACE

Fluid Power is one of the important contributors to the industrial technology of the future. Its impact possibly will match and may exceed that of electronics.

Although applications of fluid power are not new, it is only in the last two decades that the potential of the technology has been explored and developed. Advances have been and are being made to fully develop this potential giant.

A concerted effort by education, industry, and government to meet the needs of this technology is now underway.

Recognizing the need for curriculum development at the College level, a committee from the 1966 Fluid Power Institute at Wayne State University offers the following results of their study. Due to time limitations, only an introductory course is considered here.

More advanced courses should be given consideration as local conditions permit. It should also be noted that this outline is intended as a guide and should be adapted to the local objectives, available facilities, and professional expectations.

TABLE OF CONTENTS

Introduction. Page i

Preface. ii

Description of the Course. 1

A Proposed Course of Study. 3

An Evaluation of the Selected Textbook 5

References. 6

Laboratory Equipment. 9

Laboratory Layout. 13

Description of the Course

This should be an introductory, general survey of fluid power technology designed to acquaint students with the technical language, the basic fundamentals of fluid mechanics as applied to fluid power system design, and to give a basic understanding of the components, their design, application, operation and maintenance.

Course Objectives:

1. To know how fluid power is related and used in the manufacturing, transportation, and construction phases of industry.
2. To be able to read and use the symbolic language of fluid power.
3. To be able to demonstrate a knowledge of certain basic physical laws pertaining to the action and response of fluids under pressure.
4. To know the design, construction, and function of hydraulic components.
5. To know how to use the components in circuits applied to selected basic jobs which include pressing, lifting, and controlling speed of rotary and linear motion.
6. To know and follow safe practices that apply to working with fluid power.
7. To develop and evaluate materials, equipment, and teaching methods.

The Place of Fluid Power in the Program

Fluid Power technology is closely related to the other technologies within the power area. It is suggested that this proposed course may be either required or elective within the power area offerings in industrial technology or industrial teacher education curricula. It would be preferable to place this course in the junior or senior years since the student who has some understandings of basic industrial processes will be better able to see the relationships which exist between this technology and its applications. It would be desirable for the student to have taken a year of engineering drawing and to have had basic experiences in machine shop and electricity.

The recommended prerequisite for this course should be a minimum of two semesters of college physics.

The course should be given two hours of credit when offered on the semester plan within the major of an industrial education or an industrial technology curriculum.

The time schedule for the course should be arranged on the basis of equal time divided between lecture-demonstration and laboratory work. This could be scheduled as a one-hour lecture and two or three laboratory hours per week for one semester.

I. Introduction to Fluid Power

- A. Definition of fluid power
- B. Applications: industrial, construction, and transportation
- C. Historical events of significance
- D. Characteristics which have fostered rapid development
- E. Inherent disadvantages
- F. Safe practices

II. Units of Measurement and Physical Laws

- A. Energy, force, work, power, torque, heat, area, time rate, horsepower, speed and velocity
- B. Compressibility of fluids
- C. Force multiplication through fluid pressure
- D. Pascal's law, Boyle's law, Charles' law, Bernoulli's theorem, Toricelli's theorem and Reynold's number
- E. Types of flow
- F. Viscosity and voscosity index
- G. Pressure drop

III. Reservoirs

- A. Functions
- B. Types
- C. Parts
- D. Design Specifications
- E. Pressurized, scavenger, and settling tanks; heat exchangers
- F. Maintenance requirements

IV. Symbols and Diagrams

- A. Types of circuit diagrams and uses
- B. Symbols
    - 1. Derivation
    - 2. Symbols, rules for drawing and interpretation
    - 3. Proposed changes

V. Pumps: Gear, Vane, and Piston

- A. Methods of classification
- B. Design characteristics
- C. Operational characteristics
- D. Controls and adjustments
- E. Installation and maintenance

VI. Valves

- A. Classification of valves:
    - 1. Function and size
    - 2. Physical design and methods of mounting
    - 3. Types of control
    - 4. Effect upon circuit requirements
- B. Two way valves

- C. Directional control valves
- D. Pressure control valves
- E. Flow control valves
- F. Operational characteristics and circuit applications

VII. Actuators

- A. Cylinders
  - 1. Construction features, types, and sizes
  - 2. Seals, packings
  - 3. Principles of operation and application
  - 4. Mountings
- B. Motors
  - 1. Types
  - 2. Variations in design
  - 3. Applications

VIII. Fluids

- A. Classifications
- B. Physical characteristics and measurements
- C. Additives and conditioning agents
- D. Methods of filtration and cleaning
- E. Types of filters and cleaning devices

IX. Plumbing

- A. Kinds and sizes of pipe, rigid tubing, flexible tubing, and hose
- B. Connections: joints and fittings
- C. Applications, selection factors

X. Pneumatics

- A. Comparable features between hydraulics and pneumatics
- B. Combined applications using air-oil systems

XI. Servo Systems

- A. What they are
- B. Special physical features
- C. What they will do

XII. Maintenance and Trouble-Shooting

- A. Diagnosis and measurement
- B. Preventive maintenance
- C. Corrective procedures

An Evaluation of the Selected Textbook

The recently published book, Industrial Fluid Power, Vol. I. by Charles S. Hedges, Womack Machine Supply Co., Dallas Texas, is recommended as the text for this course. This selection has been strongly influenced by the large size and clarity of the illustrations which are line drawings. Names of the parts of the object drawn, and graphic indication of the direction of movement adds greatly to their understanding.

The text material should present no difficulty for the average student since the author defines and explains the technical terms cleary, and writes in a direct style. Explanations of component structure, and their function within a circuit, lead the reader to develop clear concepts of fundamental operations.

The table of contents is expanded by the inclusion of subtopics so that the usual index is not necessary. The author includes in the appendix a glossary of terms and a list of questions for each chapter.

This book was selected after examination of most of the books listed in the following section of this paper. All of these books, along with others that may be expected to be released soon, should be made available as reference material.

REFERENCES

Altland, George, Practical Hydraulics, Vickers Incorporated, Administrative and Engineering Center, P.O. Box 302, Troy, Michigan, 48084.

Ernst, Walter, Oil Hydraulic Power and its Applications, McGraw Hill Book Co., New York, N.Y. 1960.

__________, Fluid Power Handbook and Directory, Industrial Publishing Corporation, Cleveland, Ohio.

Hedges, Charles S., Industrial Fluid Power, Vol. I. Womack Machine Supply Co., 2010 Shea Road, Dallas, Texas, 1966.

__________, Field Engineers Hydraulic Circuit Selector Handbook, International Basic Economy Corporation, Akron, Ohio, 1965.

__________, Hydraulic Systems for Industrial Machines, Socony Mobil Oil Company, Inc., New York, N.Y. 1959.

__________, Industrial Hydraulics Manual, Vickers Incorporated, Administrative and Engineering Center, P.O. Box 302, Troy, Michigan. 1965.

NAVPERS 16193, U.S. Navy, Basic Hydraulics, Superintendent of Documents, Washington 25, D.C.

__________, Operation and Care of Hydraulic Machinery, The Texaco Co., 135 East 42nd Street, New York, N.Y.

Pippenger and Hicks, Industrial Hydraulics, McGraw Hill Book Co., New York, N.Y. 1962.

Pippenger and Kaff, Fluid Power Controls, McGraw Hill Book Co., New York, N.Y.

Stewart, Harry L., Hydraulic and Pneumatic Power for Production, The Industrial Press, 93 Worth Street, New York, N.Y.

Stewart, Harry L., Practical Guide to Fluid Power, Howard W. Sams and Co., Inc., New York, N.Y. 1966.

FILMS AND FILM STRIPS

Films:

"Hydraulic Oils" "Texaco Oils Rando H.D."	Texaco, Inc. 135 East 42nd Street New York 17, N.Y.
"The Hidden Giant" "Controlled Power"	Vickers, Inc. Administrative and Engineering Center P.O. Box 302 Detroit, Michigan
"Cavitation" "Harnessing Liquids"	Shell Oil Company Rockefeller Center New York, N.Y.
"Hydraulic Turret Traversing Mechanism"	The Oilgear Company 1560 W. Pierce Milwaukee 4, Wisconsin
"Automation Today" "This is Automation"	Ford Motor Company Supervisor Training Dept. Dearborn, Michigan
"Basic Principles of Hydraulics"	Jam Handy Organization 2821 S. Grand Blvd. Detroit, Michigan
"Operation Push Button"	Bellows Valvair Division of IBEC Akron 9, Ohio

Film Strips:

"Elements of Compressed Air" "Elements of Hydraulics" "Pneumatic Circuitry" "Preparing Air for Use"	Parker Hannifin Corporation Cleveland, Ohio
"Fluid Power: The Muscles and Nerves of Modern Industry"	Modernair Corporation San Leandro, California
"Directional Control Valves" Set of 2 x 2 slides	Double A Products, Co. Manchester, Michigan

TRANSPARENCIES

There are several sets of Commercial Transparencies available. Should the reproduction equipment be available at the school, these may be made by the instructor.

PROGRAMMED INSTRUCTION

Several companies are preparing programmed instruction materials and will make these available to schools.

Miller Fluid Power Division of the Flick Reedy Corporation, Bensenville, Illinois, is one of these.

LABORATORY EQUIPMENT

The fluid power laboratory by nature implies activity. The extent and effectiveness of this activity will be affected by the availability of physical facilities and equipment. It is therefore of prime importance to select such equipment only after giving careful consideration to the objectives and purposes of the program.

Imagination and ingenuity on the part of the instructor are perhaps one of the most valuable assets in the development of the laboratory.

There are several commerical Fluid Power stands available. Recognizing that each may have inherent strenghts and weakness, it is not the intent of this study to make specific recommendations. The following criteria is suggested when making selections:

Brand________________________________Type______________________

Factors	Adequate	Acceptable	Inadequate
1. Size and capacity Motor Pump			
2. Manual, number, and type of experiments			
3. Instrumentation			
4. Hook up time			
5. Components a minimum of (2) cylinders (different size) (2) 3 piston, 4 way directional valves (1) hydraulic motor (1) flow control valve (2) sequence valves adequate hoses and connectors			
6. Adequate safety devices			
7. Cut away components			
8. Portability			
9. Versatility			
10. Design and Construction			
11. Cost			

The following units are presently available. They are not listed in order of preference. Company literature should be consulted for specifications and specific features.

Name	Hydraulic	Pneumatic	Combined
Capital	x	x	
Electromatic	x	soon	
Scott	x		
Technical	x	x	x
Vega	x	x	x
Vickers	to be announced soon		

The teacher may well consider shop-made set-ups with commercial components and achieve satisfactory results. In either event, it would be wise to have various components availalbe for dissassembly and cut-aways.

Equipment and Tools

Other necessary and desirable equipment for the fluid power laboratory would include the following items:

Machine Tool Equipment:
- Machine lathe
- Drill press
- Grinder
- Air compressor

Instrumentation:
- Pressure gauges (Hydraulic and Pneumatic)
- Vacuum gauges
- Air flow meter
- Oil flow meter
- Manometer
- Ammeter
- Volt meter
- Ohmeter
- Universal force gauge
- Thermometer
- Tachometer

Measuring:
- Micrometer (inside and outside)
- Feeler gauges
- Steel rules
- Steel tape

- Hole gauges
- Thread gauges

Wrenches:
- Open end
- Box end
- Socket set (6 and 12 point)
- Torque
- Adjustable
- Allen
- Pipe

Screw Drivers:
- Common
- Phillips

Threading tools and equipment:
- Pipe taps and dies
- Machine taps and dies (UNF and UNC)
- Screw extractors
- Thread chaser

Pliers:
- Combination
- Snap-ring
- Long nose
- Side-cutting
- Diagonal
- Water pump

Drills and reamers:
- Twist drills (fractional, letter, and number)
- Reamers (pipe, straight, and adjustable)

Hammers:
- Ball peen
- Soft face

Files: (general assortment)

Cutting tools:
- Pipe and tube cutter
- Flexible hose cutter
- Hack saw
- Sloyd knives

Chisels and punches:
- Cold
- Drift
- Pin
- Center
- Brass

Miscellaneous:
- Tube flaring kit
- Tube bending kit

Gasket cutters
Gear pullers
Seal inserters and removers
Crimping tools
Oilers
Soldering gun
Oily rag cans
Funnels

LABORATORY LAYOUT

Realizing that Fluid Power might be included with other courses, it was generally felt that a seperate laboratory, designed for fluid power instruction would be of great importance. This would not only provide more room but would tend to create prestege and effeciency. Desirable features would include a seperate, instructional area, work area, store room, and instructor's office.

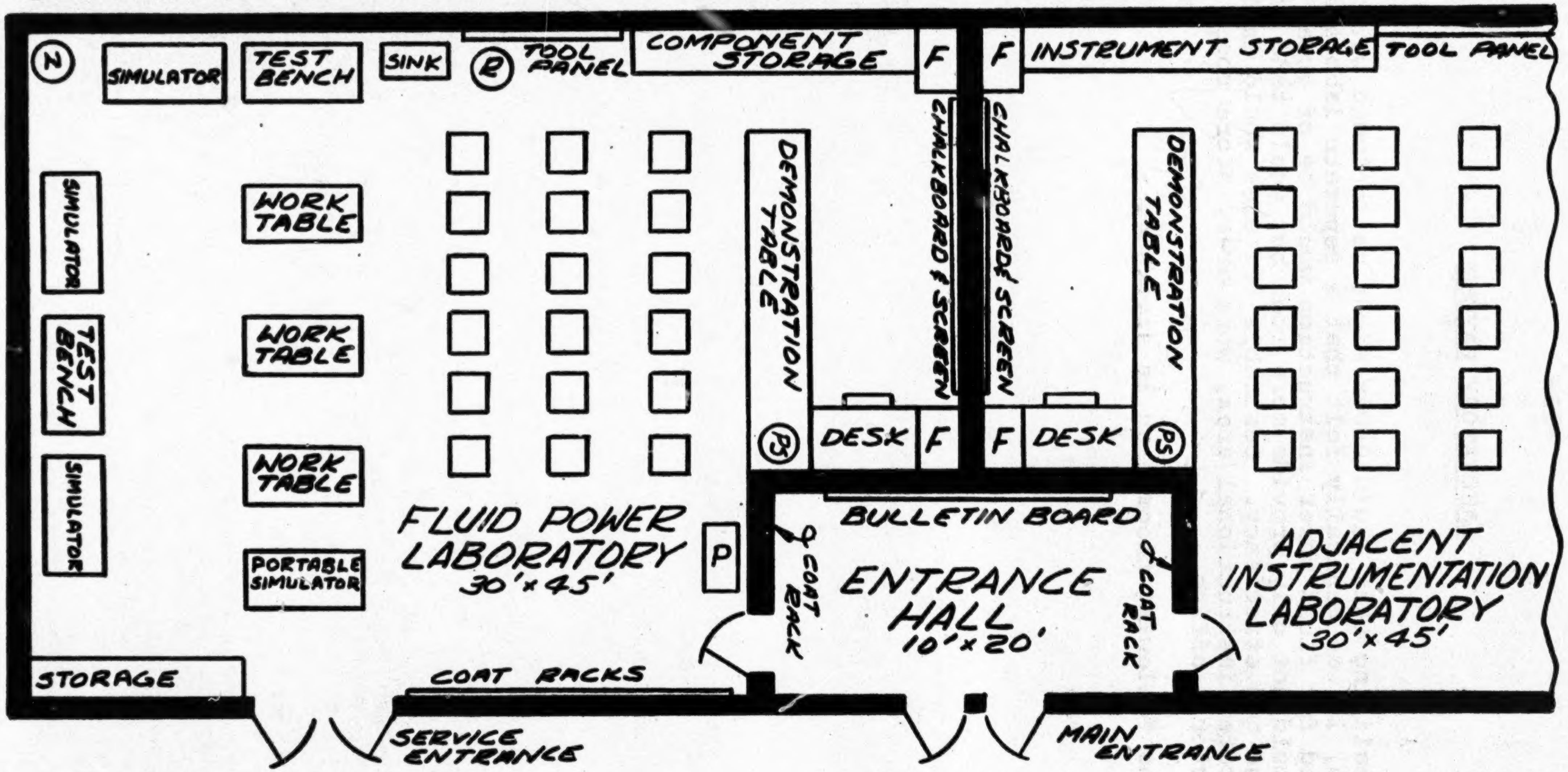
The following floor plan is suggested:

SPECIFICATIONS

AIR COMP. 40 C.F.M.-120 P.S.I. 4 PLACES EA. LAB.
HOT & COLD WATER AT SINKS
FIRE EXTINGUISHER IN EACH LAB.
HARDWOOD FLOORS---2 PORTABLE CHALKBOARDS
200 AMP. 110-220 V. SERVICE IN EACH LAB.

KEY

Ⓕ FILE CABINETS
Ⓝ NITROGEN TANK
Ⓟ PERIODICALS & BOOKS
ⓅⓈ PANIC SWITCH - FOR ALL EXCEPT LIGHTS -
Ⓡ RAG DISPOSAL


N
SIMULATOR
TEST BENCH
SINK
R
TOOL PANEL
COMPONENT STORAGE
F
F
INSTRUMENT STORAGE
TOOL PANEL
SIMULATOR
TEST BENCH
SIMULATOR
WORK TABLE
WORK TABLE
WORK TABLE
PORTABLE SIMULATOR
DEMONSTRATION TABLE
CHALKBOARD & SCREEN
CHALKBOARD & SCREEN
DEMONSTRATION TABLE
PS
DESK
F
F
DESK
PS
FLUID POWER LABORATORY 30'x45'
P
BULLETIN BOARD
COAT RACK
ENTRANCE HALL 10'x20'
COAT RACK
ADJACENT INSTRUMENTATION LABORATORY 30'x45'
STORAGE
COAT RACKS
SERVICE ENTRANCE
MAIN ENTRANCE

PLANS FOR FLUID POWER LABORATORY

FOR MECHANICAL ENGINEERING TECHNOLOGY CURRICULUM

SCALE $\frac{1}{8}'' = 1'\text{-}0$ -18 STUDENTS PER SECTION- BY R. CURTIS & G. SIMONEAU
JULY 28, 1966